

TWR-64392  
ECS #: SS5116

## Case Inner Diameter "Spider" Pitting Investigation, Process Simulation Article (PSA), Final Test Report

5-Nov-1993

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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*Thiokol* CORPORATION  
SPACE OPERATIONS

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(NASA-CR-196587) CASE INNER  
DIAMETER SPIDER PITTING  
INVESTIGATION, PROCESS SIMULATION  
ARTICLE (PSA) Final Report  
(Thiokol Corp.) 161 D

# **Case Inner Diameter "Spider" Pitting Investigation, Process Simulation Article (PSA), Final Test Report**

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CASE INNER DIAMETER "SPIDER" PITTING INVESTIGATION,  
PROCESS SIMULATION ARTICLE (PSA),  
FINAL TEST REPORT

5-Nov-1993

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## TABLE OF CONTENTS

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1.0	INTRODUCTION .....	1
2.0	OBJECTIVE .....	1
3.0	SUMMARY AND CONCLUSIONS .....	2
	3.1 SUMMARY .....	2
	3.2 CONCLUSIONS .....	2
4.0	RECOMMENDATIONS .....	3
5.0	DISCUSSION .....	3
	5.1 TEST DESCRIPTION .....	3
	5.2 INSTRUMENTATION .....	3
	5.3 PHOTOGRAPHS .....	4
	5.4 TEST DATA .....	4
	5.5 TEST IMPLEMENTATION .....	4
	5.5.1 PRETEST .....	4
	5.5.2 PSA-9 TEST .....	4-7
	5.5.3 PANEL TEST .....	7-8
6.0	REFERENCES .....	8-9
	6.1 THIOKOL DOCUMENTS .....	8-9

## LIST OF FIGURES

Figure 1	Line of Pits on PSA-9 Test Area # 22 . . . . .	10
Figure 2	Post-Cure Insulation on PSA-9 Test Area #22 . . . . .	11

## **1.0 Introduction**

Case inner diameter (ID) pitting in the acreage has been noted during the refurbishment process since early in the SRM/HPM phase of the shuttle program. Corrosion under cured insulation has long been thought to be caused by the use of Methylchlorform (TCA). TCA can cause different acids (HCL and Nitric) to be formed during NBR insulation cure at elevated temperature and pressure (TWR-61501). More recently a corrosion/pitting phenomena has been noticed (spider pitting) which causes extensive pitting of case hardware and appears black with legs and a large pit in the center - hence the term spider pitting. Pits have been recorded with the deepest being .065.

Process Simulation Article - 9 (PSA-9) was used to simulate the actual insulation process utilizing insulation processing parameters and associated materials. The different insulation lay-up processing anomalies for PSA-9, were developed by PTP-0032/TWR-64407, and included scenarios (thin CHEMLOK, excessive TCA, TCA and water, no CHEMLOK 205, scratches in the chemlok surfaces) thought to cause pitting and corrosion in D6AC steel. 32 witness panels accompanied the PSA-9 article, incorporating testing scenarios which could not be tested on flight hardware, including different quantities of acid, acid and water, localized charring of the insulation, and different inclusions under the insulation.

All the data except for long-term aging test panels 24,25,31, and 32 are documented in this report. The four test panels will be examined and documented in a supplement of this report in one year. Based on the past testing no spider pitting is expected from these four panels.

Numerous photographs were taken while conducting this test. Because of the large number of photographs and the cost associated with reproducing them in a report, the complete set of photographs will be presented in TWR-64392-Appendix A located in data management.

## **2.0 Objective**

The objective of this test was to attempt to create "spider" pitting using suspected "worst case" processing variations on full scale hardware and witness panels to determine:

1. If the normal insulation process was contributing to the case ID spider pitting phenomenon.

2. If thin or spotty CHEMLOK was contributing to the cause of spider pitting.
3. If varying amounts of TCA and water could cause spider pitting.
4. If extreme conditions coupled with the insulation process could cause the spider pitting.

### **3.0 Summary and Conclusions**

#### **3.1 Summary**

The PSA-9 full scale activity and accompanying witness panels were processed with no out of family events taking place. Pitting was produced in one test area, when large amounts of water and TCA were injected under the insulation. This pitting does not look like the regular case ID spider pitting. No spider pitting was noted either in the full scale PSA-9 test article or in the panels checked to date (4 panels will be aged for 12 more months). No spider pitting was produced from this test.

#### **3.2 Conclusions**

During the processing of PSA-9, a team from THIOKOL at KSC, found extensive pits under nozzle impact damaged areas in a recently fired segment (reference TWR-65638). These new findings and those of the PSA-9 activity lead to the conclusion that the spider pitting is a post flight phenomenon (reference TWR-65533).

Conclusions from ETP-1139 are as follows:

1. Normal RSRM insulation processing did not produce pitting in the PSA-9 test article or the accompanying test panels.
2. Spotty or thin CHEMLOK did not contribute to any spider pitting.
3. Increased CHEMLOK 205 primer did not affect case ID pitting production.

4. A line of pits, .011 inch deep, were produced when large amounts of water and TCA (5 milliliters) were injected under the insulation.
5. The line of pits generated by the worst case conditions did not look like regular case ID spider pits.

#### 4.0 Recommendations

The findings of PSA-9 activity indicate that no problems exist with the insulation processes, and that the spider pitting phenomenon is a post flight issue. Based on the findings of the PSA-9 activity, it is recommended that nothing be done to change the case preparation/insulation operation to reduce or eliminate spider pitting.

#### 5.0 Discussion

Process Simulation Article - 9 (PSA-9), a full-up aft segment, was used to simulate the actual insulation process utilizing insulation processing parameters and associated materials. (36) different insulation lay-up processing anomalies, were developed from results of PTP-0032/TWR-64407, included scenarios (thin CHEMLOK, excessive TCA, TCA and water, no CHEMLOK 205, scratches in the chemlok surfaces) thought to cause pitting and corrosion in D6AC steel. These tests were located in membrane of the fwd stiffener. 32 witness panels accompanied the PSA-9 article, incorporating testing scenarios which could not be tested on flight hardware, including different quantities of acid, acid and water, higher than normal processing temperatures, localized charring of the insulation, and different inclusions under the insulation.

The PSA-9 testing was performed in M-52/M-111 and utilized actual processes and materials currently used in RSRM production.

The (32) witness panels were processed in M-52/M-111 and in M-86.

##### 5.1 Test Description

The test description was completed as outlined in ETP-1139, deviations were coordinated with the spider team leader.

##### 5.2 Instrumentation

The inspection equipment used met the National Institute of Standards per MIL-STD-3-45662.

5.3      Photographs were identified as outlined in ETP-1139.

5.4      The test data requirements were coordinated with Robert McBride, Dr. Marvin Hawkins, Tollison Beames, and members of the spider pitting team.

5.5      Test Implementation

5.5.1    Pretest

The PSA-9 and the 32 test panels were processed with the standard manufacturing procedures for grit blast, degrease, and CHEMLOK application. No pits in the hardware were noted.

5.5.2    PSA-9 Test

The PSA-9 was processed as a normal segment up through paint and CHEMLOK. Different tests were then performed as outlined in the PSA-9 test schedule. The spider pitting test (ETP-1139) was performed in the forward stiffener (1U50715, SN 04). The standard CHEMLOK application and rubber layup was altered as per ETP-1139.

Engineering and project engineering agreed to the following modifications to the test plan:

The test plan specified injection of the solvent(s) under the first ply of rubber. Engineering and project engineering agreed to modify the test plan and not inject all the solvent and to adjust the amount of solvent used in the test. Some test locations had solvent injected but in most test locations the solvent was not injected. Instead of injecting the solvent, a hole was made in the first ply of rubber and the solvent was poured into the hole. A second ply of rubber was then

placed on top of the hole to trap the solvent.

The volume of solvent used on the PSA and the test panels was reduced from the volume specified in the test plan. A typical volume used for the test was 0.1 milliliter; reduced from the 1 milliliter stated in the test plan. These modifications were made to more accurately simulate the production environment and to reduce the time required on the production line.

As stated in the test plan, insulation in specified test areas was applied to the case then peeled off the Chemlok surface in a effort to damage the chemlok coating. After peeling the insulation no chemlok damage was noticed.

Other variables tested per ETP-1139 are as follows:

1. Zero or Two coats of Chemlok 205 primer.
2. Two coats of Chemlok 233 adhesive.
3. Injecting methyl chloroform (without added water) under the insulation.
4. Adding water saturated asbestos.
5. Peeling off the insulation to cause Chemlok damage.
6. Introducing bubbles in the insulation.
7. Introducing and rolling out bubbles in the insulation.
8. Damaging the Chemlok with a needle tip.
9. Contaminating the surface with HD-2 grease.
10. Injecting ocean water with the Ph adjusted to 5.0 under the insulation.
11. Activating the insulation with MEK.

12. Adding metal shavings as contamination under the insulation.
13. Storing the insulation at high humidity prior to use.
14. Having a reduced vacuum during cure.
15. Charing the insulation.
16. Applying pressure to the panels to simulate the flight pressure.
17. Storing the cured panels in high humidity.
18. Placing the panels in simulated ocean water.
19. Injecting methyl chloroform / hydrochloric acid under the insulation.

After cure, the insulation was noted to be blackened where methyl chloroform was added under the insulation. Two large discolored bubbles were noted at test areas 22 and 34. Test area 22 at the location of the bubble was injected with 2.5 milliliters of methyl chloroform and 2.5 milliliters of ASTM D-1141 ocean water with the Ph adjusted to  $5.0 \pm 0.5$ . Test area 34 at the location of the bubble was injected with 2.5 milliliters of methyl chloroform and 2.5 milliliters of water. Figure 2 shows test area 22 with the large discolored bubble in the insulation. Engineering and project engineering agreed to modify the test plan by taking a sample of the gas under the bubble in test area 22. Adjacent insulation was cut around the bubble, a sample of the metal surface residue was taken and analyzed. The bubble in test area 34 was left as a control. The gas from the bubble was a hydrogen gas / air mixture. When the bubble in test area 22 was removed a line of deep narrow pits 1.2 inch long by 2/32 inches wide by 0.0110 inch deep, were discovered and sampled. Material removed from the pits was determined to be Chemlok®. Figure 1 shows the line of pits after insulation washout. When the pits were reexamined after insulation washout it was determined that the pits did not grow.

Photos are listed in TWR-64392- Appendix A. Photos of the post-cure insulation and of the bare metal after insulation removal were taken for each test area on PSA-9.

The test plan did not specify the length or temperature of storage for the PSA article and most of the panels. The entire PSA article was stored in the propellant surge bay at approximately 135°F and ambient humidity, for of 90 days. These conditions were chosen by the case ID pitting team to simulate the propellant casting operations.

The PSA segment was washed out after the 90 day extended storage. No spider pitting or spider legs were noted in any of the 36 tests. Non-typical case pitting was produced in test area 22.

### 5.5.3 Panel Test

Each test panel was designed to test different processing variations as outlined in ETP-1139. The gritblast, degrease, and CHEMLOK were applied in the M-52/M-111 manufacturing area. The layup and panel preparation was completed in M-86. All were processed using current materials and processes. All panels were layed up with two (2) plies of 0.100 inch nominal thickness NBR rubber applied to the CHEMLOK per the manufacturing process unless otherwise stated below. Chemical injections were inserted between the insulation and CHEMLOK coating(s) per ETP-1139 instructions.

Engineering and project engineering agreed to the following modifications to the test plan:

Test panels 20, 21, 22, and 27 were insulated with insulation stored at 80% relative humidity for three days. This was done to determine if humidity levels of the insulation had an effect on case ID pitting.

Test panels 18, 21, 22, 23, 24, 27, and 32 were reinjected with solvent in some locations just prior to insulation cure. This was done due to the longer than usual time the panels were under vacuum waiting cure of the PSA article.

The panels were cured using IRD-209A cure cycle. The vacuum bag, and patterning cloth were removed after cure. The panels were stored at ambient temperature and humidity, and then moved to the propellant surge area to stored with the PSA-9 article for an additional 90 days at 135 deg F.

Panels 9, 10, and 11, had half the normal vacuum, instead of no vacuum, during the insulation cure. If no vacuum was used during the insulation cure, the rubber would not bond to the panel. A simulation of the low vacuum which may occur in the case was the objective of this part of the test.

The insulation on test panels 3, 5, and 7 were charred with a TU-172 end burner motor after the three month storage.

The high humidity storage test panels (number 4 and 8) were stored for 3 months at 80% relative humidity and approximately 135°F. The extended storage test panels 24, 25, 30, 31, and 32 are being stored for 360 days minimum at 80% relative humidity and approximately 135°F.

All panels except the extended storage test panels 24, 25, 30, 31, and 32 were washed off at H7. None demonstrated pitting or any spider legs.

## 6.0 References

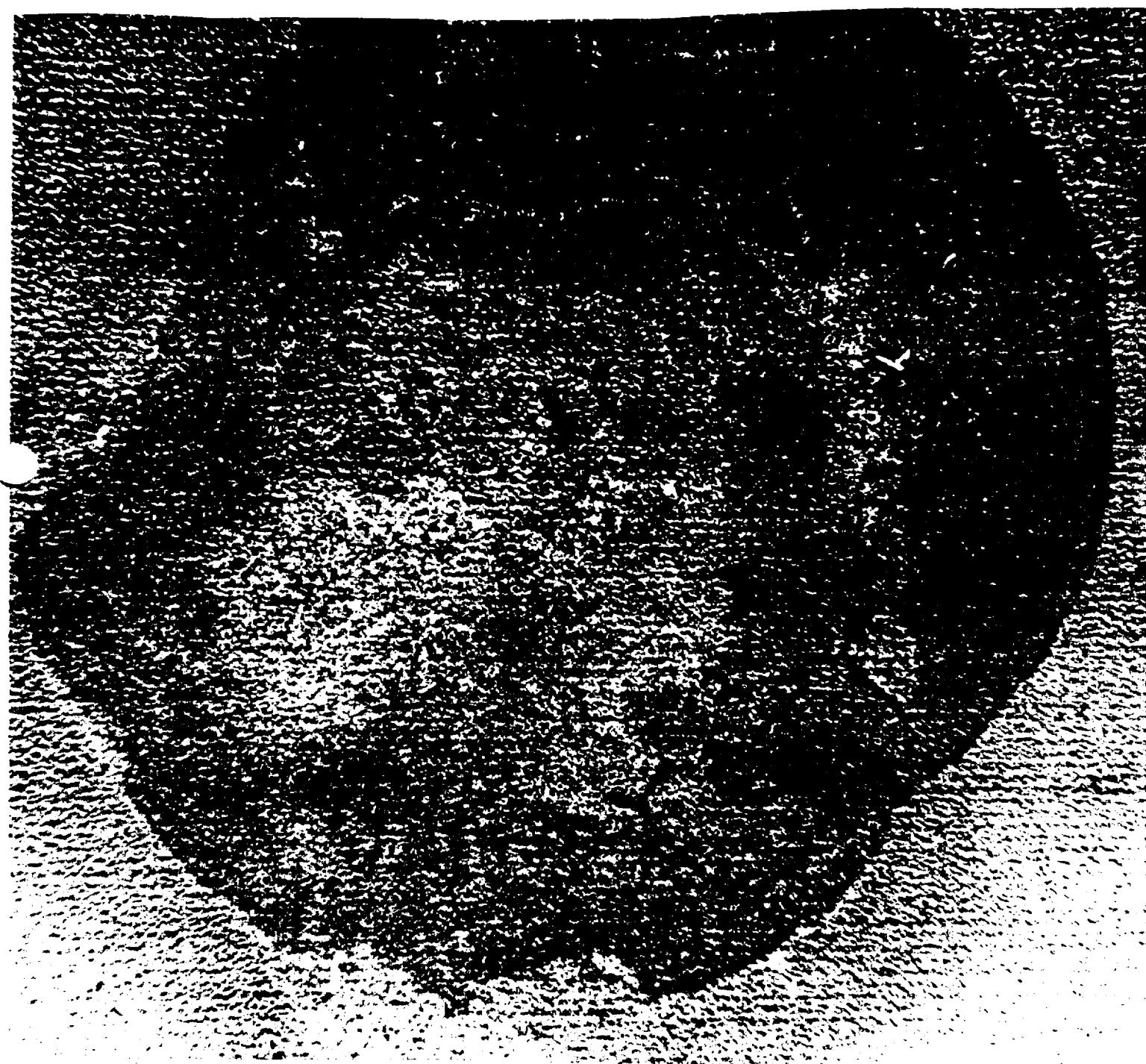
### 6.1 Thiokol Documents

STW5-2664	Adhesive Primer, Rubber to Metal. (CHEMLOK	205)
STW5-2798	Adhesive, Rubber to Metal, Elevated Temperature Curing.	
STW7-2831	Inspection and Process Finalization, Critical, Insulated Components, Space Shuttle Solid Propellant Rocket Motor.	
STW7-2744	Acceptance Criteria, Refurbished Case, Space Shuttle SRM.	
STW5-2712	Bonding Agent, Rubber-to-Metal (CHEMLOK 233).	
ASTM D-1141	Substitute Ocean Water, Standard Specification for	

- TWR-61501      A Review of Studies on Case Inner Diameter Pitting
- TWR-64407      Report for PTP-0032 Spider Pitting Corrosion Study
- TWR-65637      Acid Formation Caused by a TCA/Water Mixture During Case Insulation Cure
- TWR-65533      Case Inner Diameter Pitting Investigation, Summary of

Figure 1

Line of Pits on PSA-9 Test Area # 22  
0.011 inch deep  
1.8X Magnification

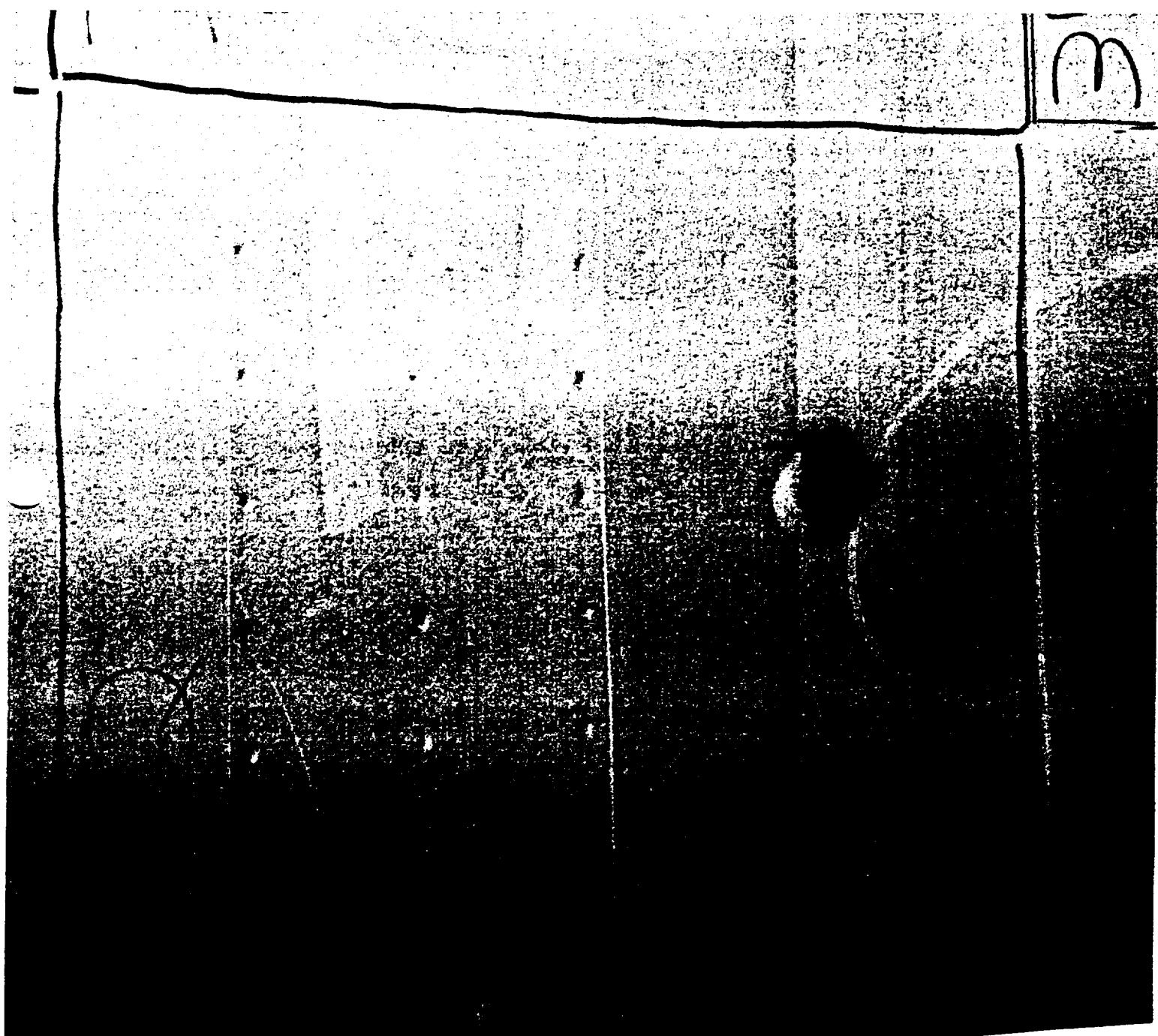


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**Figure 2**      Post Cure Insulation on PSA-9 Test Area # 22  
                  0.2X Magnification .



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TWR-64392  
Case Inner Diameter  
"Spider" Pitting Investigation,  
Process Simulation Article (PSA-9),  
Final Test Report

## APPENDIX A

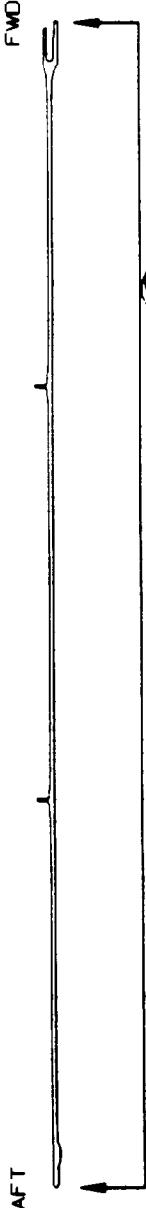
This appendix has four sections

- 1) PSA-9 Test Areas  
Photos of each test area after insulation cure.  
Note the blackened insulation where TCA was used.
- 2) PSA-9 Test Areas  
Photos of each test area after the insulation and Chemlok® were removed with a water blast.
- 3) PSA-9 Test Areas  
Diagrams of each test area. Which test variables, locations, and quantities are specified.
- 4) Test Panels  
Diagrams of each test panels. Which test variables, locations, and quantities are specified.

The original document contains poorly reproduced photographs which were not filmed.

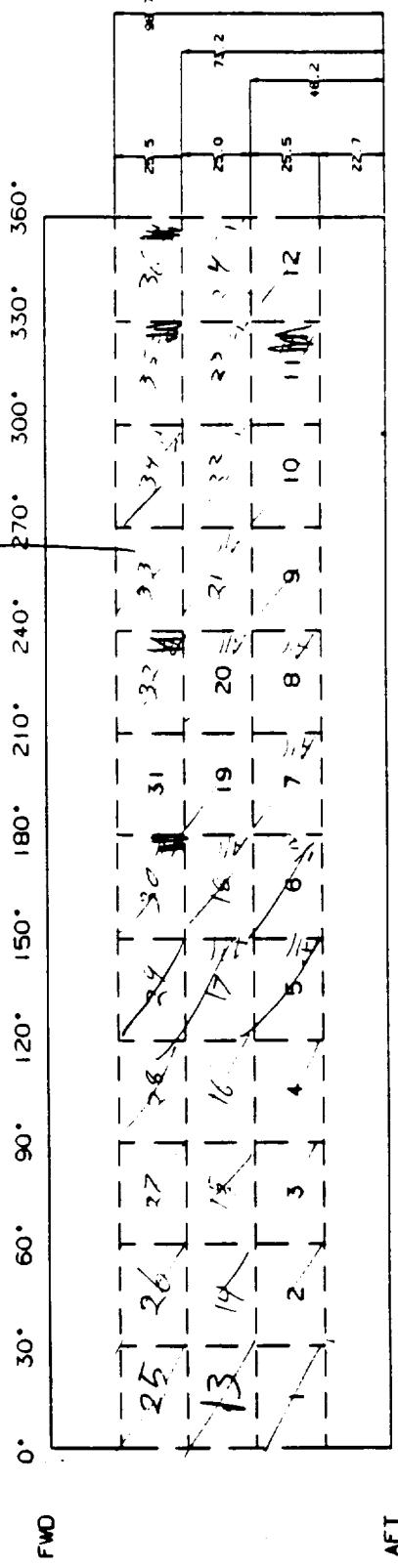
## SPIDER PITTING TEST (CHEMLOK APPLICATION)

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exact  
degree  
locations  
are corrected  
on each sketch



VIEW A-A

SPIDER PITTING TESTS WILL TAKE PLACE (IN THE FWD STIFFNER).



VIEW A - A

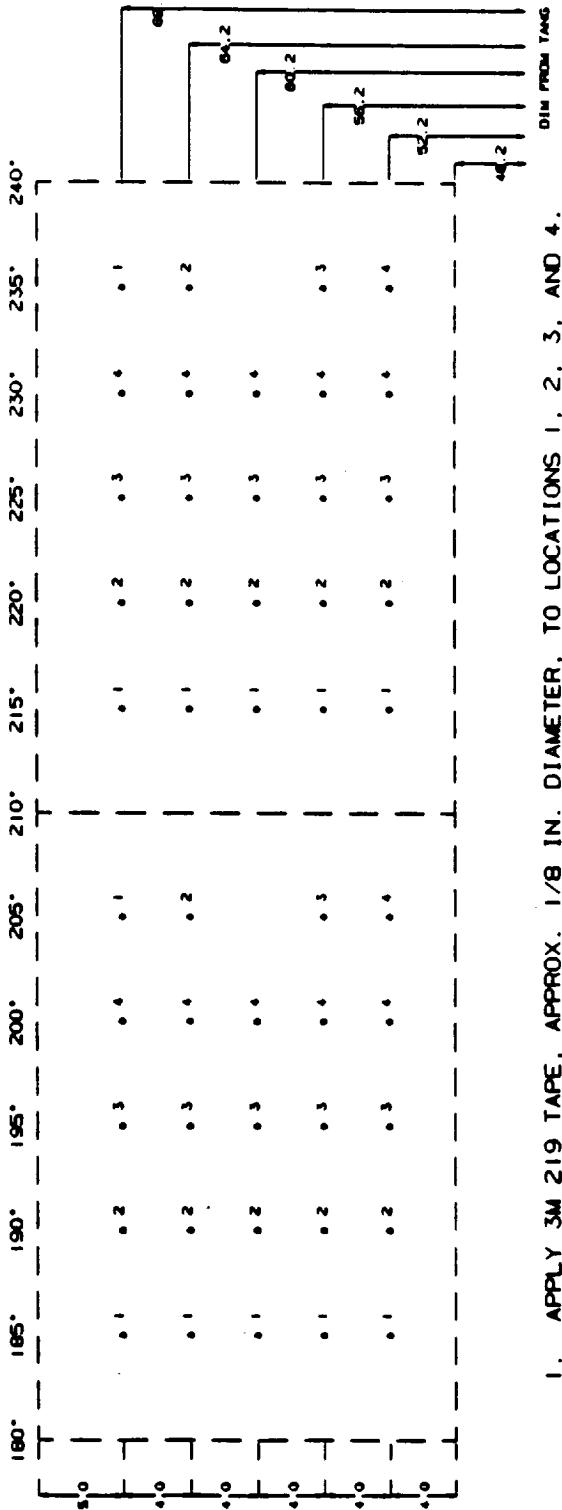
- PER SHEET 1. 2. APPLY 3M 219 TAPE TO TEST AREAS 19 AND 20.  
 PER SHEET 2. OUTLINE MASK FOR 205 APPLICATION WITH 3M 219 TAPE.  
 PER SHEET 3. OUTLINE TEST AREA 3-1. MARK DEGREE LOCATIONS ON TAPE FOR  
 TEST AREAS 12 AND 31 FOR LATER REFERENCE.  
 4. ASSEMBLE PAINT AND CONSCAN.  
 PER SHEET 3. APPLY GREASE TO LOCATIONS NOTED.  
 REMOVE OUTLINE TAPE AROUND TEST AREA 3-1.  
 PER SHEET 4. MASK FOR 205. SPRAY 205. UNMASK, AND COMPLETE 205 APPLIC.  
 PER SHEET 2. REMOVE TAPE FROM TEST AREA 19 AND 20 AS NOTED.  
 PER SHEET 5. MASK FOR 233. SPRAY 233. UNMASK, AND COMPLETE 233 APPLIC.  
 PER SHEET 2. REMOVE TAPE FROM TEST AREA 19 AND 20 AS NOTED.  
 REFERENCE DOCUMENT: ETP 1139

TOLERANCES: ± .5

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<small>ANNE L. BRADY CAD/CAM NURSE CHIEF</small>					

SPIDER PITTING TEST (CHEMLOK APPLICATION)

200  
|  
○



1. APPLY 3M 219 TAPE, APPROX. 1/8 IN. DIAMETER, TO LOCATIONS 1, 2, 3, AND 4.
2. APPLY CHEMLOK 205 PRIMER.
3. REMOVE TAPE FROM LOCATIONS 1 AND 3 ONLY.
4. APPLY CHEMLOK 233 ADHESIVE.
5. REMOVE TAPE FROM LOCATIONS 2 AND 4.

TOLERANCES: ± .5

REFERENCE DOCUMENT: ETP 1139

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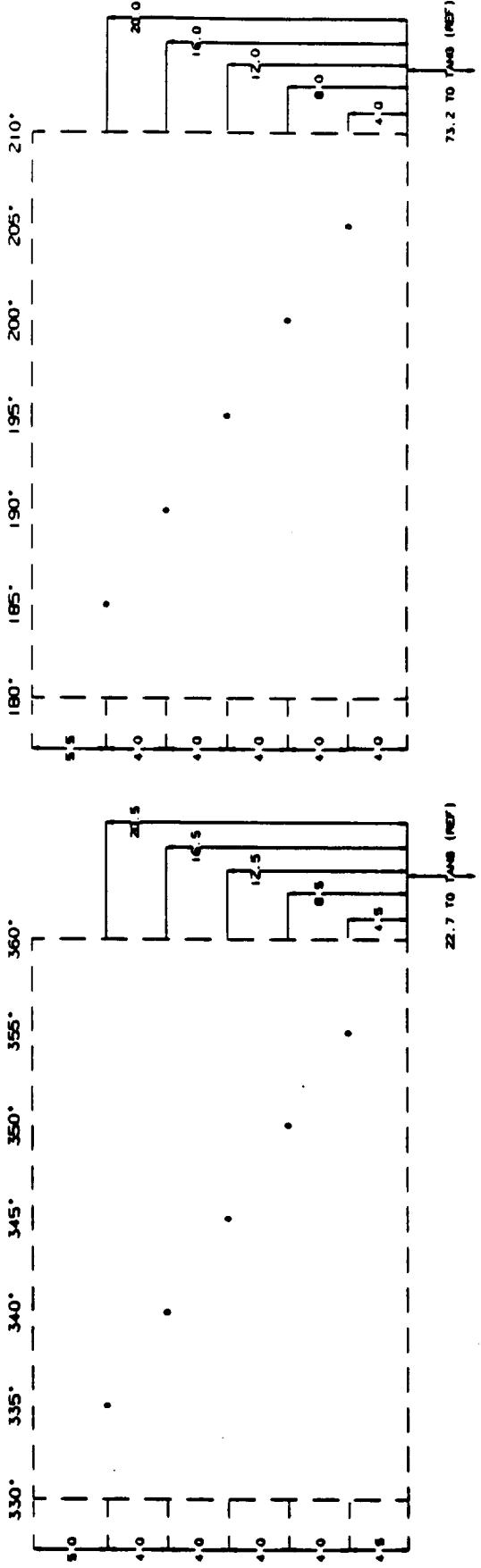
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2 OF 5

SPIIDER PITTING TEST (CHEMLOK APPLICATION)

| 2



1. DIMENSIONS NOTED ARE FROM EDGE OF TAPE OUTLINING TEST AREA. (TEST AREA DEG LOCATIONS WILL BE LAYED OUT PRIOR TO ASSEMBLY.)
2. APPLY HO-2 GREASE TO LOCATIONS DEFINED APPROX. 1 IN. DIAMETER. (PER ENG. DIR.)
3. DRY-WIPE TO ACHIEVE DIS-COLORATION. (PER ENG. DIR.)

TOLERANCES: ± .5

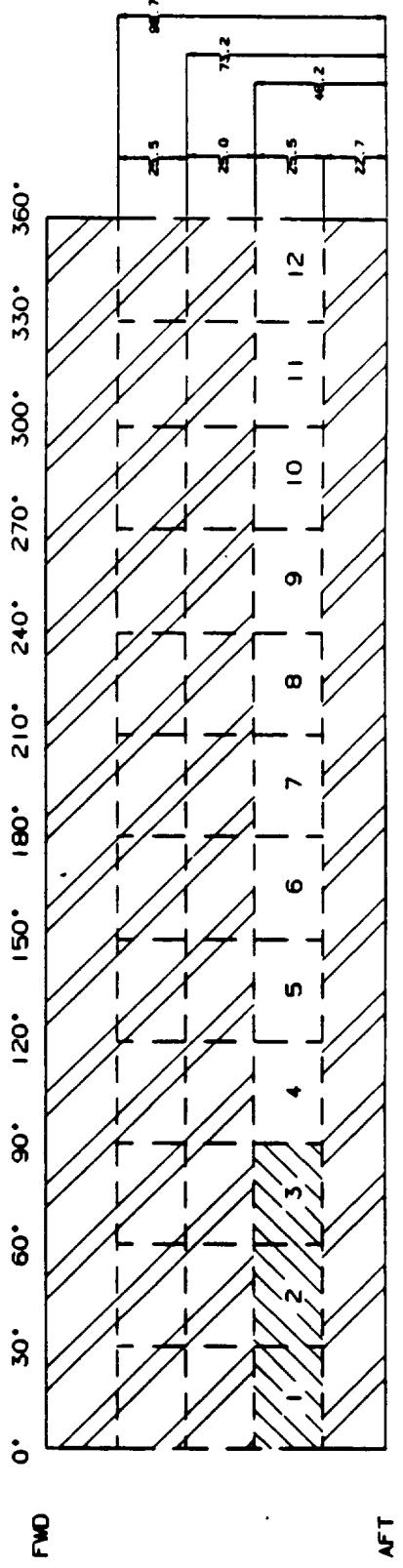
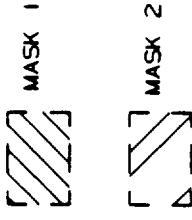
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## SPIDER PITTING TEST (CHEMLOK APPLICATION)

### CHEMLOK 205

1. USE 3M 219 TAPE AGAINST BARE METAL TO OUTLINE TEST AREAS.
2. FOR EASE OF ACCESS, APPLY 3M 219 TAPE PRIOR TO THE 219 TAPE.
3. AS REQUIRED, MASK AREAS DEFINED BY MASK 1.
4. AS REQUIRED, MASK AREAS DEFINED BY MASK 2.
5. APPLY ONE COAT CHEMLOK 205 TO AREAS 4 - 12.
6. REMOVE MASKING DEFINED BY MASK 2.
7. APPLY CHEMLOK 205 TO ENTIRE CASE SURFACE.
8. REMOVE MASKING DEFINED BY MASK 1.



VIEW A-A

TOLERANCES: ± .5

REFERENCE DOCUMENT: ETP 1139

APPROVED BY: CAD/CAM TEAM: DATE: 08/08/08

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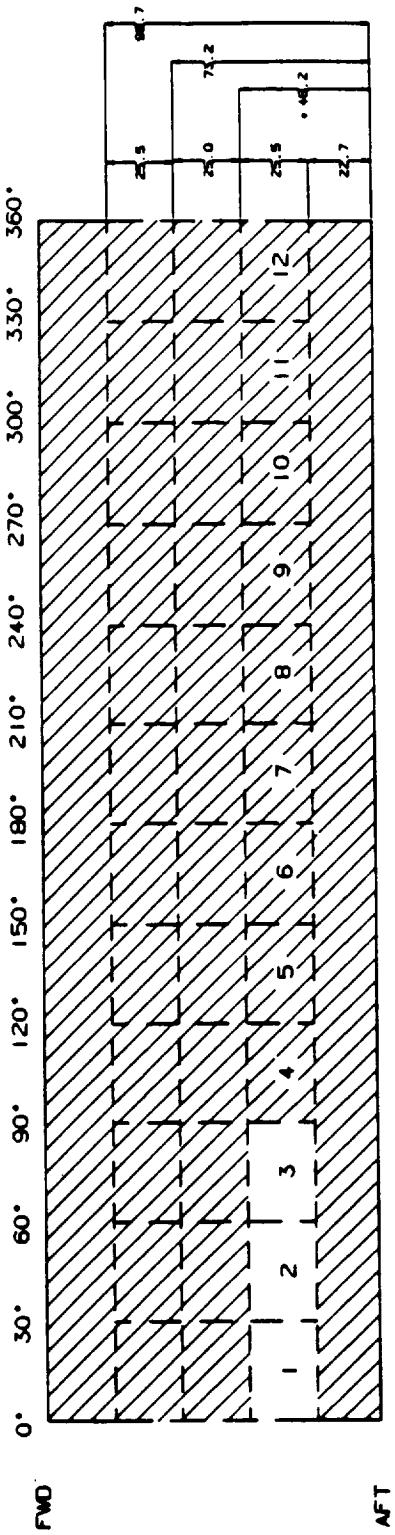
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**Thiokol** CORPORATION  
SPACE OPERATIONS  
MANUFACTURING DIVISION  
CADD/CAM

## SPIDER PITTING TEST (CHEMLOK APPLICATION)

### CHEMLOK 233

1. USE 3M 219 TAPE AGAINST CHEMLOK 205 TO OUTLINE TEST AREAS.
2. MASKING TAPE CAN BE USED TO FASTEN PAPER TO THE 219 TAPE AS REQUIRED. MASK AROUND AREAS 1, 2 AND 3 USING 3M 219 TAPE.
3. COVER CASE AS REQUIRED WITH PAPER.
4. APPLY ONE COAT OF CHEMLOK 233 TO AREAS 1, 2 AND 3.
5. REMOVE ALL MASKING MATERIAL.
6. APPLY CHEMLOK 233 TO ENTIRE CASE.



VIEW A-A

TOLERANCES: ± .5

REFERENCE DOCUMENT: ETP 1139

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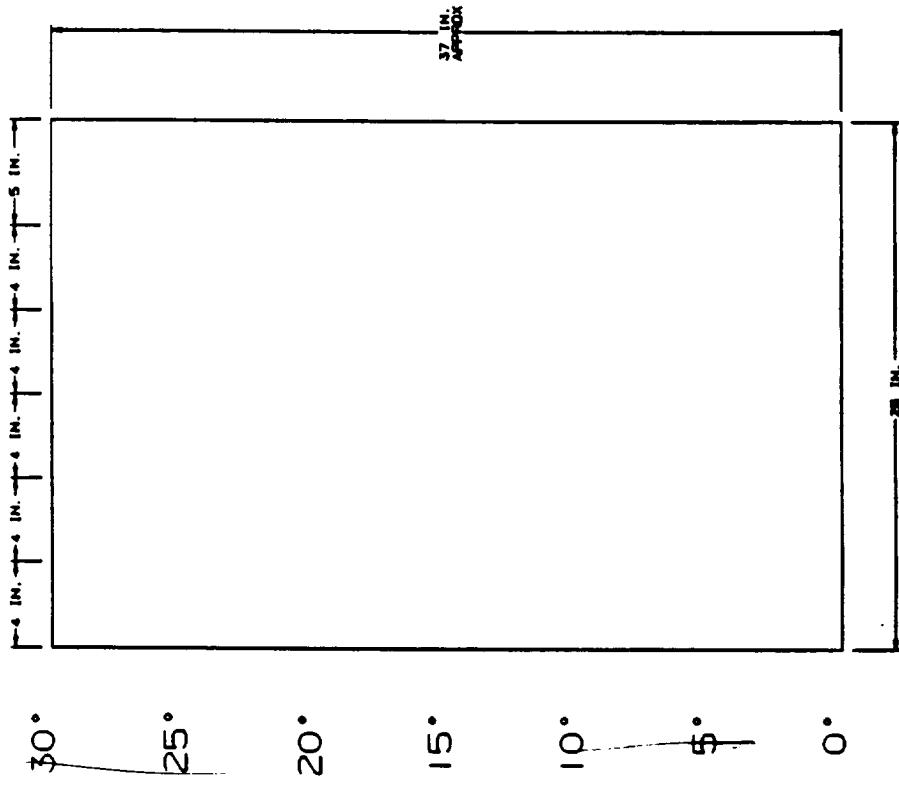
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PAGE

5 OF 5

Note to all sketches

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TEST AREA # 1

1. APPLY BOTH PLYS OF NBR ACTIVATED WITH TCA.

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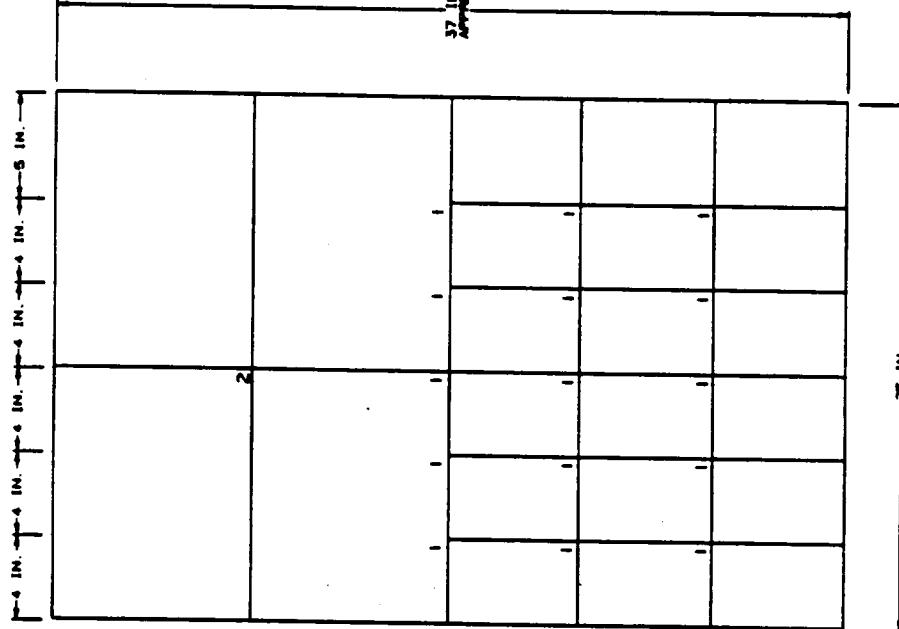
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## TEST AREA # 2

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1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
2. INJECT TCA BETWEEN NBR CHEMLOK.
3. A. 15 cc OF TCA AT LOC. 1 holes  
B. 15 cc OF TCA AT LOC. 2 inject  
3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

maximum hole capacity

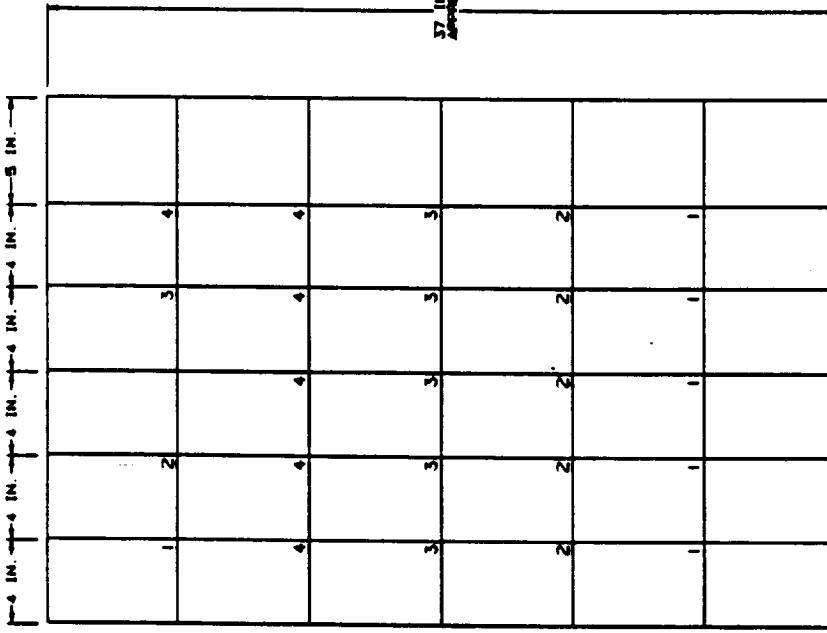
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TEST AREA # 3



58° 50°

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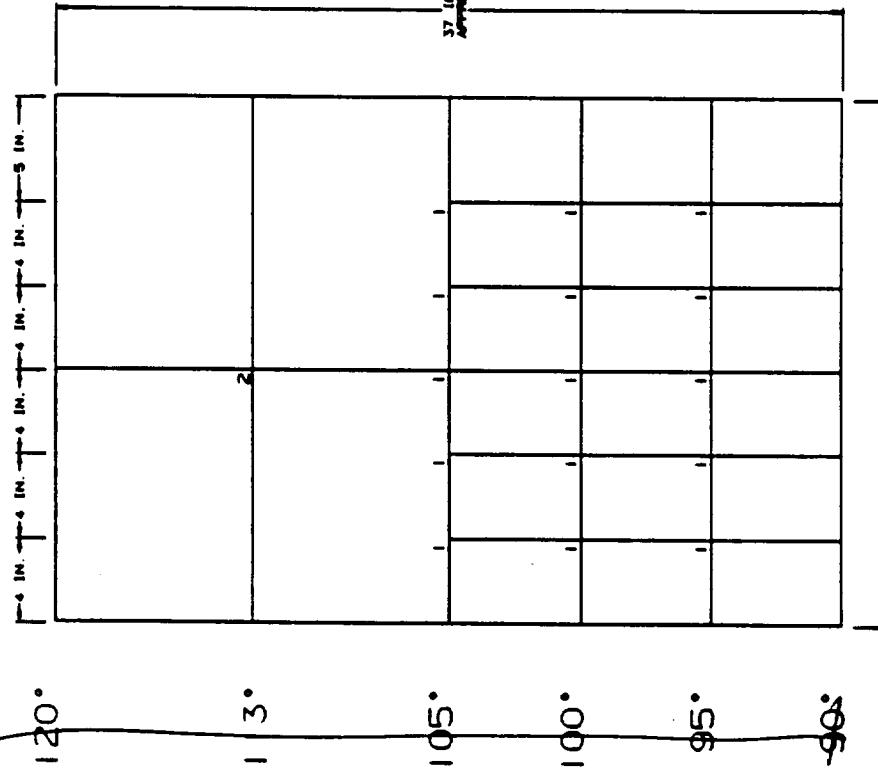
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TEST AREA # 4



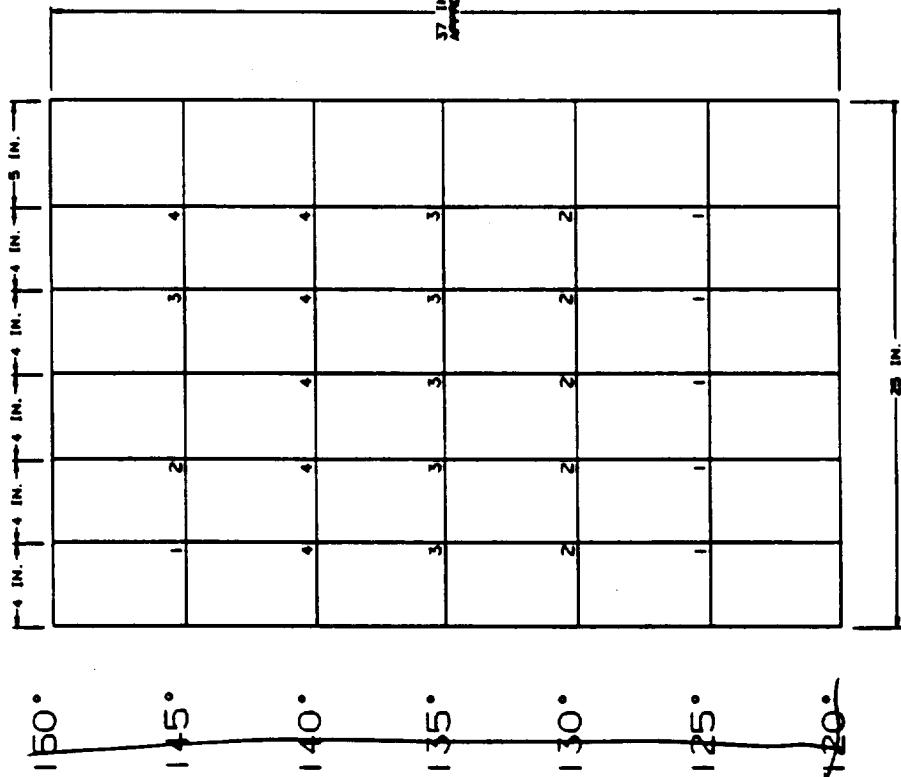
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~~AFT~~ → ← FWD ~~AFT~~

TEST AREA # 5



150°

15°

10°

5°

0°

5°

10°

15°

4  
REF

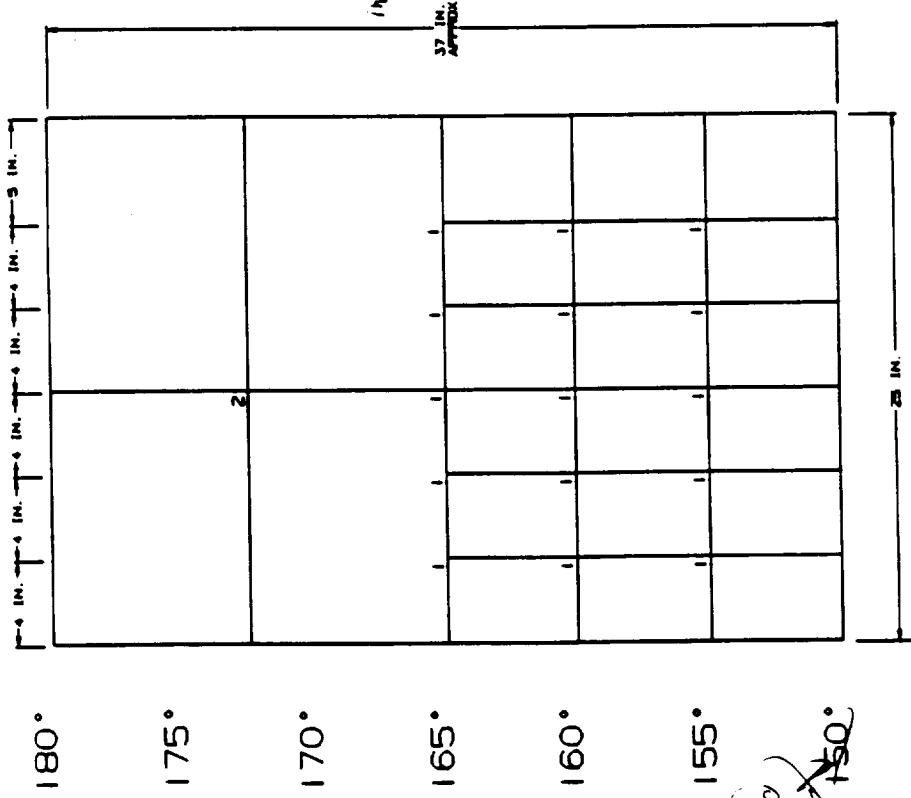
1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA. AFTER 15 SECONDS, REMOVE NBR FROM CHEMLOK. EXAMINE CHEMLOK FOR DEFECTS.
2. DOCUMENT DEFECTS ON SKETCH.  
A. EXAMINE CHEMLOK FOR DEFECTS. IF NO DEFECTS ARE CREATED, RETRY STEPS 1 AND 2 VARYING TIMES OF NBR ADHESION.
3. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK. ADJUST INJECTION POINT TO CORRESPOND WITH DEFECTS DOCUMENTED IN STEP 2.  
holes A. 1 cc OF (0.000) WATER :  
holes B. 1 cc OF (0.001) WATER :  
holes C. 1 cc OF (0.01) WATER :  
holes D. 1 cc OF (0.1) WATER :  
holes E. 1 cc OF (1.0) WATER :
4. APPLY SECOND LAYER OF NBR ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SKETCH NO. SK77428MS-03

PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77429-03	SPIDERMS-01	XXXXXX	5 CF 36

AFT → ← FWD

TEST AREA # 6



148°  
150°

4 ▲ 143. 3-  
REF

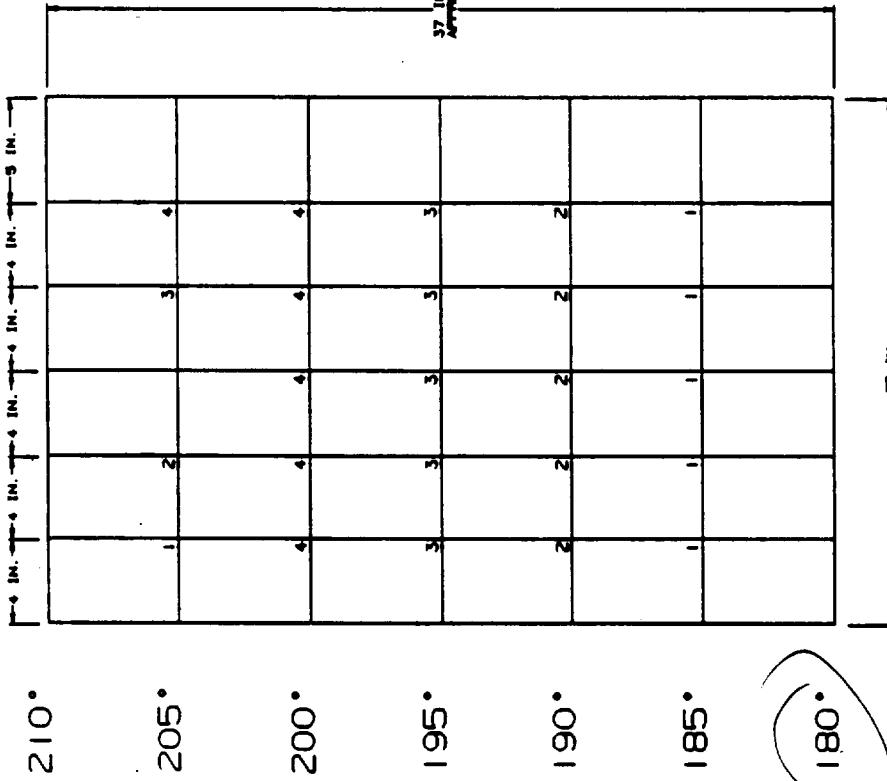
REFERENCE DOCUMENTS: ETP - 1139  
SK7428MS-03

SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION		PART NO.	PART NO.	SPIDER
		7U77428-03	7U77428-03	
		SKETCH NO.	CPI NO.	
		SPIDERMS-01	XXXXXX	6 OF 36

**Thickol** CORPORATION  
SPACE OPERATIONS  
MANUFACTURING ENGINEERING  
CADCAM CAD/CAM PAGE

AFT → ← FWD ↑

TEST AREA # 7



4 143.3-  
REF

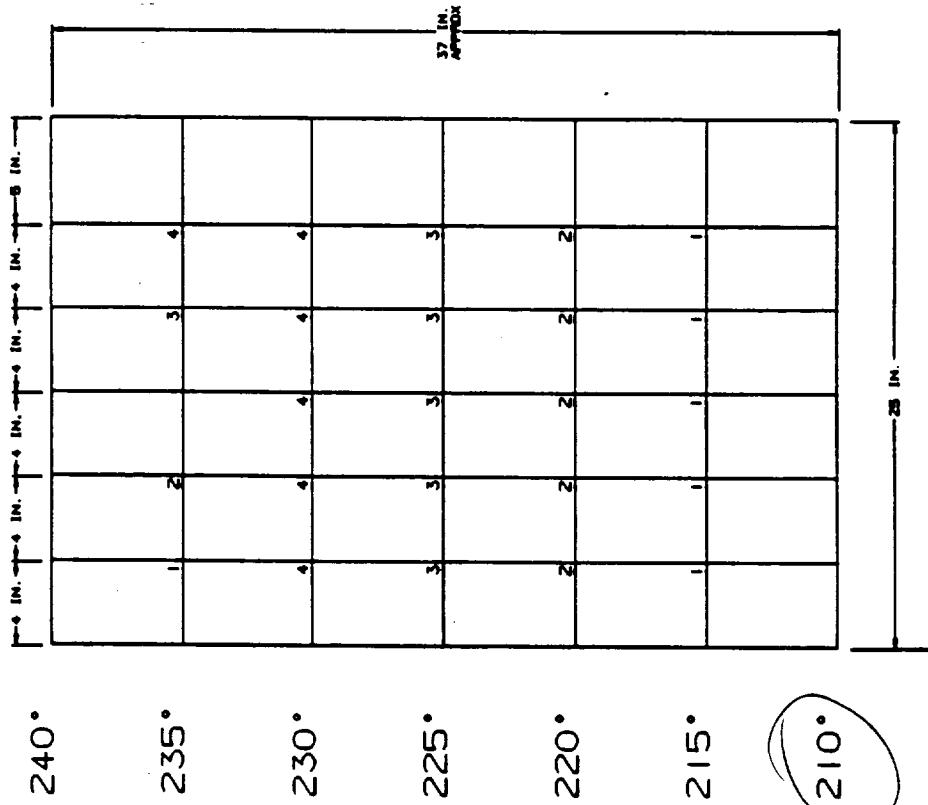
REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	SKETCH NO.	SPIDERMS-01	XX XXXX	7 OF 36
7U77428-03	CPI NO.	XXXXXXXX		

**Thickool** CORPORATION  
SPACE OPERATIONS  
www.thickool.com  
CAD/CAM PAGE

AFT → ← FWD

TEST AREA # 8

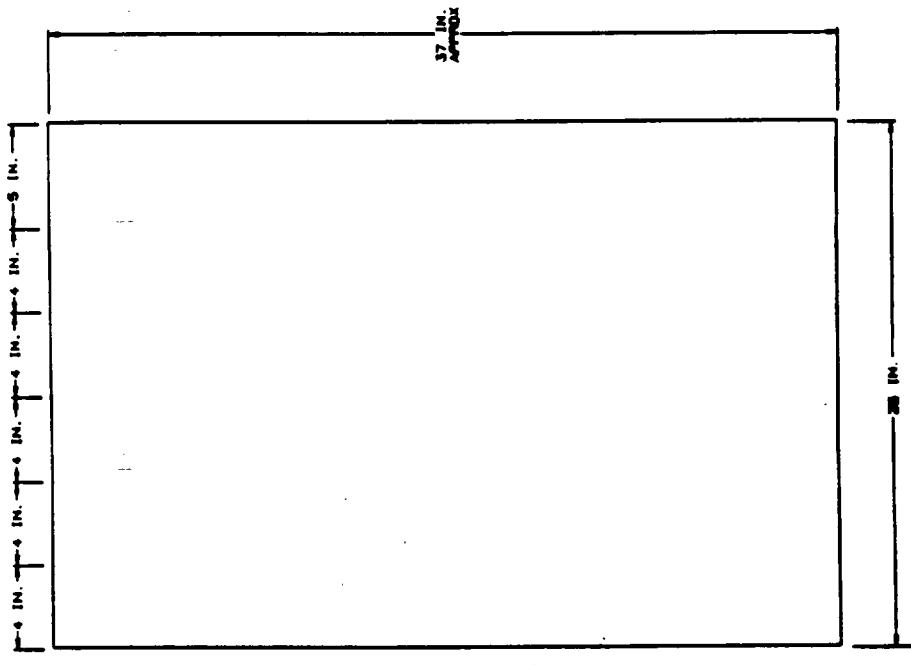


1. APPLY A SMALL PINCH OF WATER SATURATED ASBESTOS AT LOC 1, 2, 3, AND 4.
2. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77428-03	SPIDERMS-01	X XXXXX	8 OF 36

AFT → ← FWD



TEST AREA # 9

1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
2. AFTER 15 SECONDS REMOVE NBR FROM CHEMLOK. EXAMINE CHEMLOK FOR DEFECTS.
  - A. EXAMINE CHEMLOK FOR DEFECT LOCATIONS.
  - B. DOCUMENT DEFECT ON THIS SKETCH.
  - C. IF NO DEFECTS WERE CREATED RETRY STEPS 1 AND 2, VARYING TIMES OF NBR ADHESION.
  - D. REAPPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

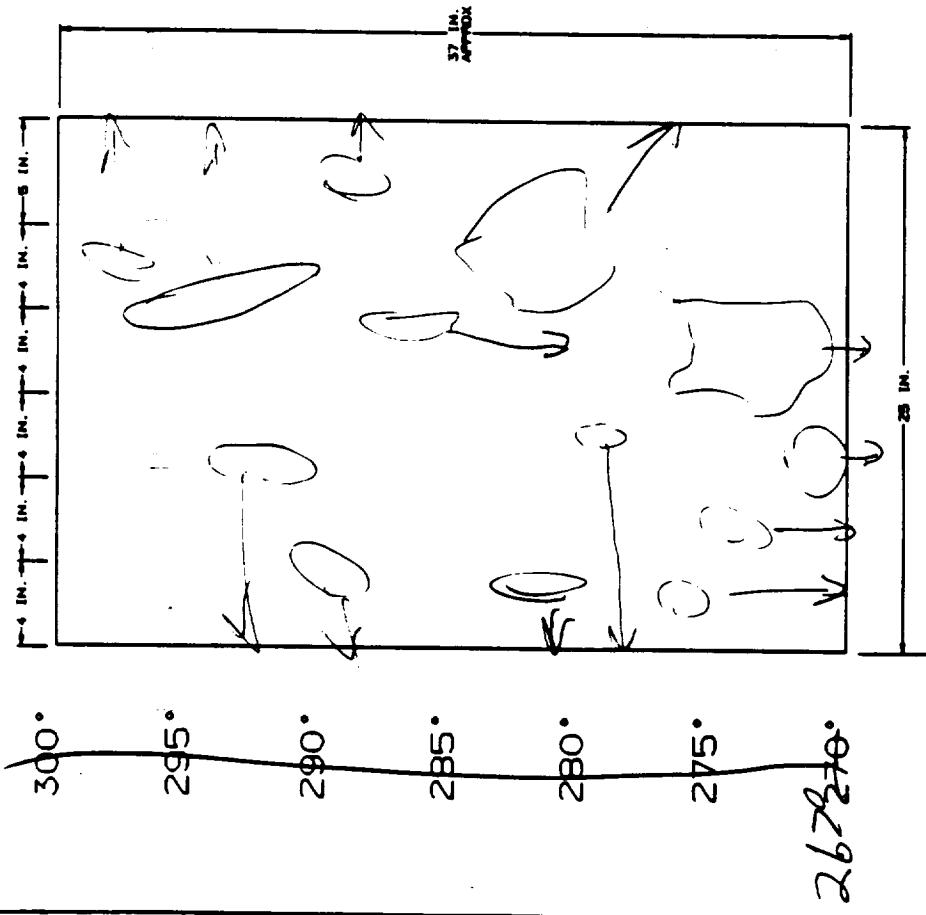
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REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

Thickel CORPORATION		PAGE
PART NO.	SKETCH NO.	
SPIDERMS-01	7U77428-03	CPI NO. XXXXX

AFT → ← FWD

TEST AREA # 10



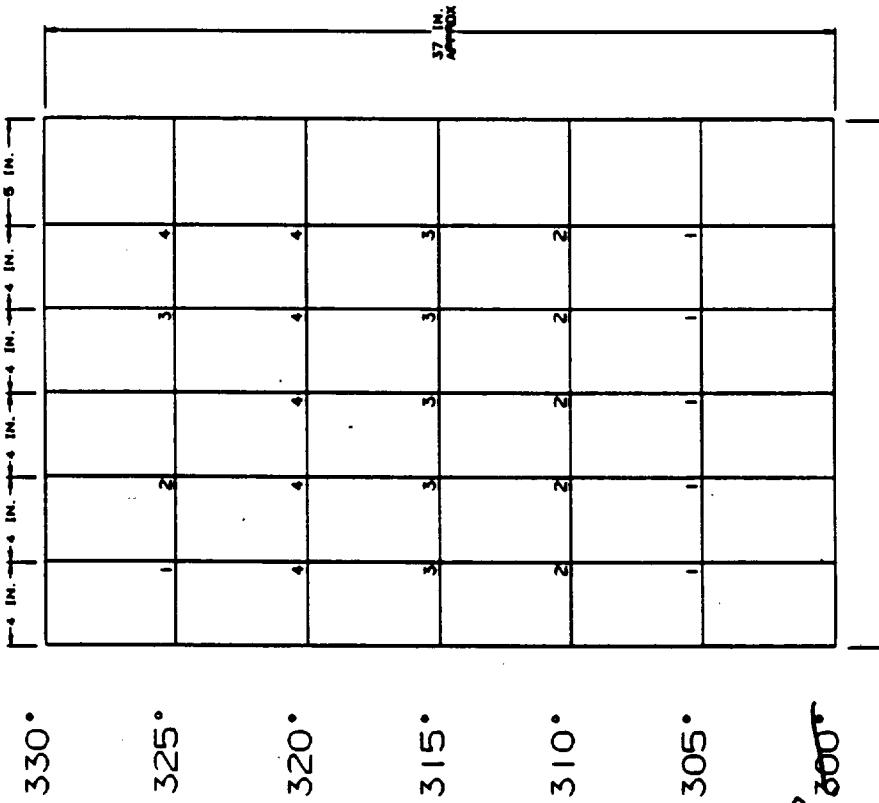
4 143.3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	7U77428-03	SKETCH NO.	CPI NO.	PAGE
<b>Thickol</b> CORPORATION SPACE OPERATIONS www.thickol.com	SPIDERMS-01	XXXXXX	10 OF 36	

AFT → ← FWD

TEST AREA # 11



296° 300°

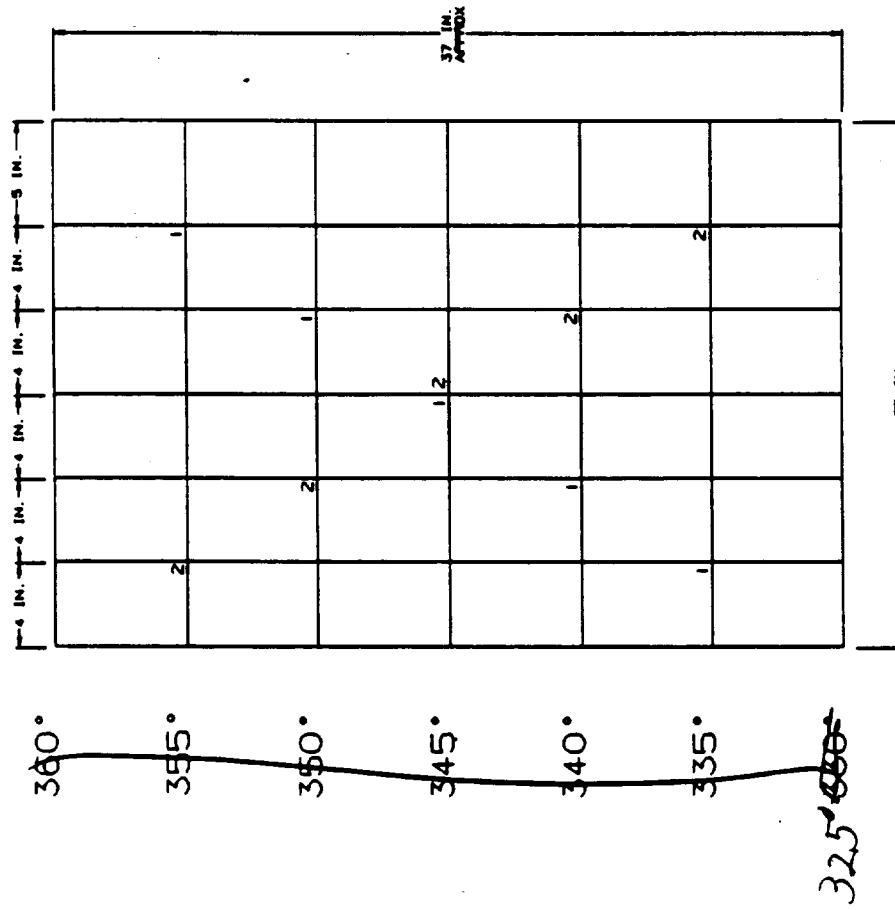
4 143.3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	SKETCH NO.	CPI NO.	PAGE
<b>7U77428-03</b>	<b>SPIDERMS-01</b>	<b>XXXXXX</b>	<b>11 OF 36</b>

AFT → ← FWD

TEST AREA # 12



4 143.3 REF

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

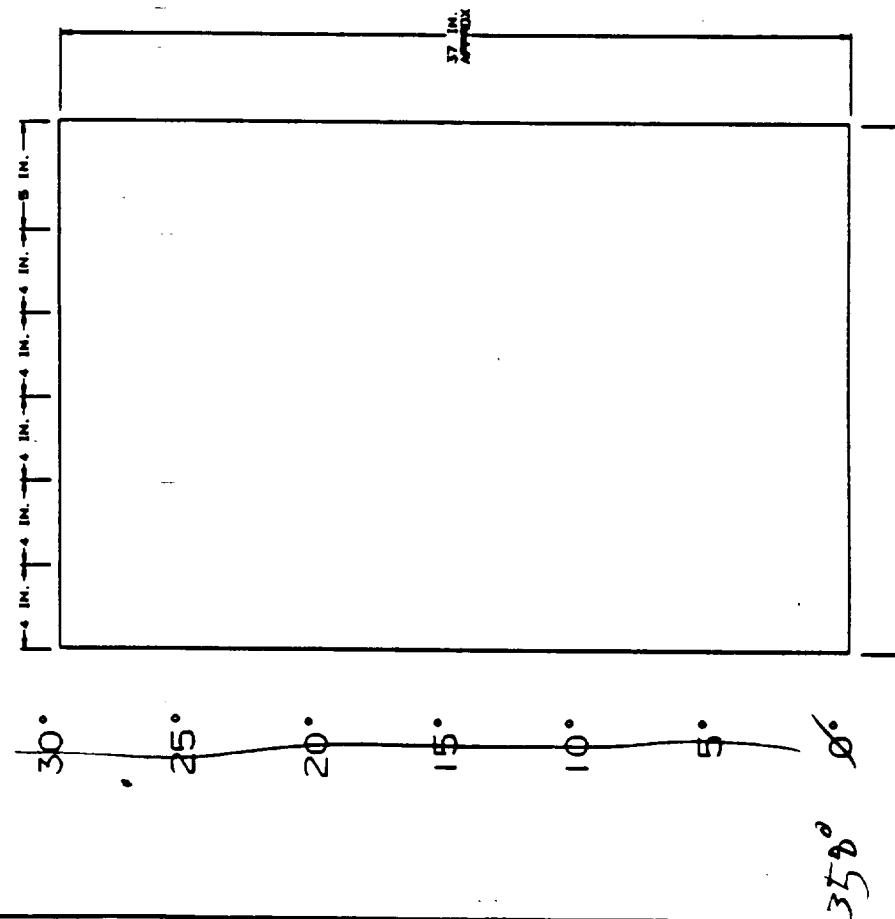
PART NO.		SKETCH NO.		PAGE	
7U77428-03	SPIDER	CP1 NO.	XXXXXX	12	OF 36
<b>SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION</b>					

**Thiokol** CORPORATION

SPACE OPERATIONS  
MANUFACTURING DIVISION • CAD/CAM

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TEST AREA # 13



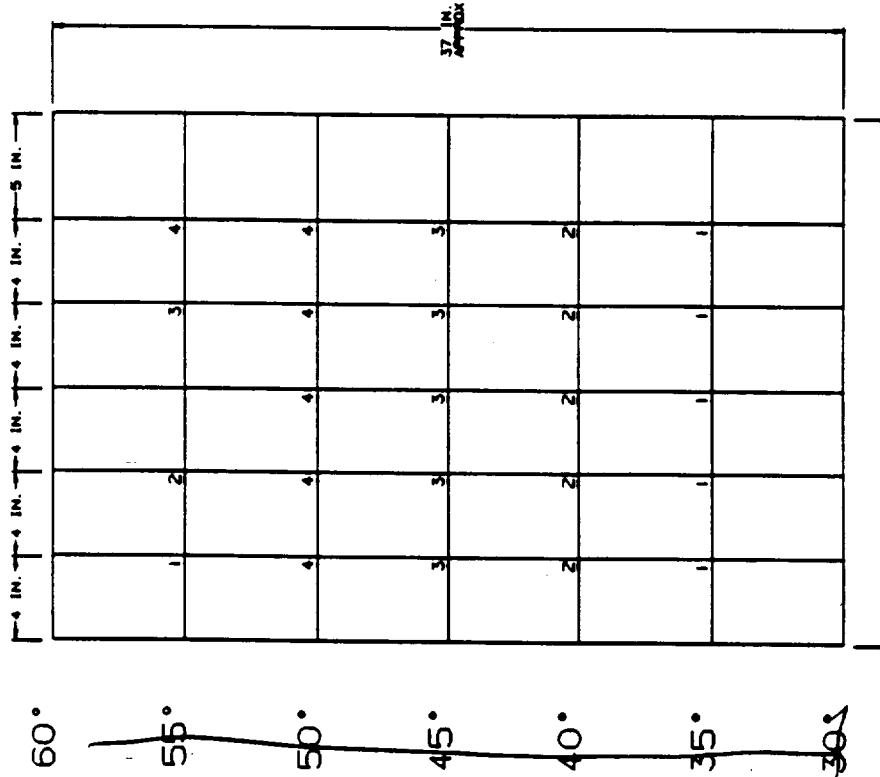
1. APPLY BOTH PLYS OF NBR ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.		SKETCH NO.		CPI NO.		PAGE
7U77428-03	SPIDERMS-01	X	X	X	X	13 OF 36
SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION						

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TEST AREA # 14 X



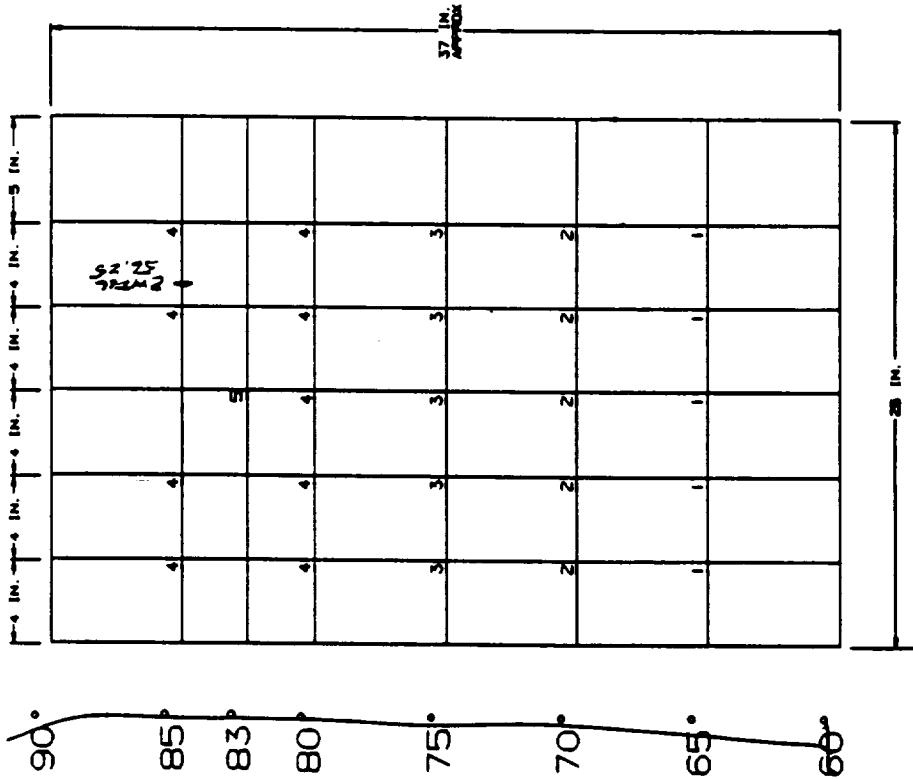
4 168.3  
REF

REFERENCE DOCUMENTS : ETP - 1139  
SK 77428MS-03

PART NO.	SKETCH NO.	CPI NO.	PAGE	<b>Thickol</b> CORPORATION SPACE OPERATIONS and Defense Systems Division
7U77428-03	SPIDERMS-01	XXXXXX	14 OF 36	SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION

 AFT →  FWD ←

TEST AREA # 15



nothing at 4

1. APPLY A SMALL PINCH OF WATER SATURATED ASBESTOS AT LOC 1, 2, 3, AND 4.
  2. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  3. INJECT TCA BETWEEN NBR AND CHEMLOK.
  4. ~~APPLY A 1/2 CC OF TCA AT LOC 1, 2, 3, 4, 5. BESIDES 1/2 CC OF TCA AT LOC 5.~~  
APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

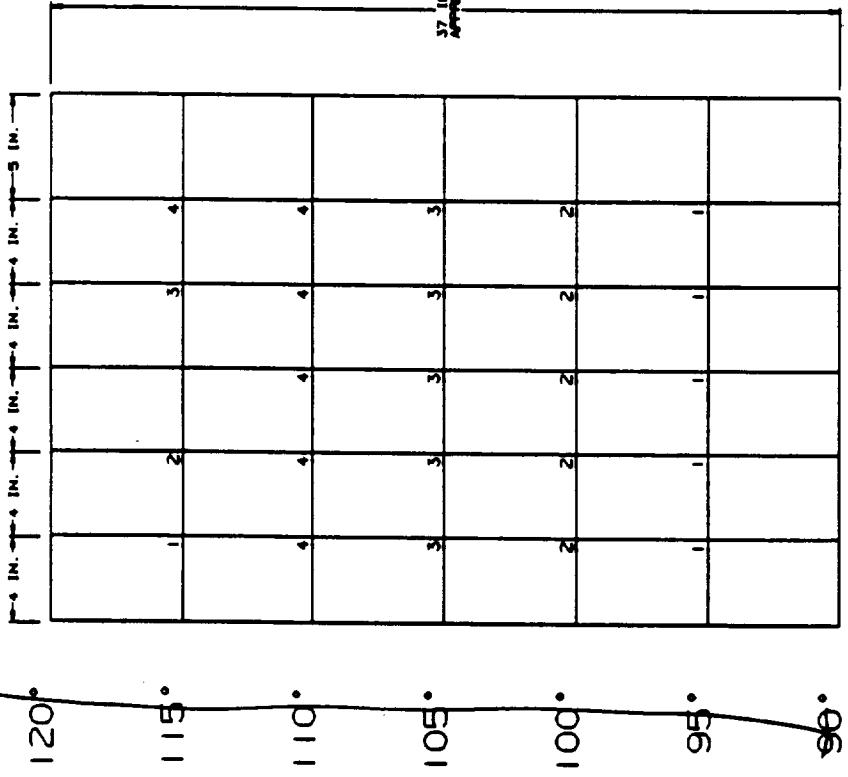
168 . 3 -  
REF  
 4

REFERENCE DOCUMENTS: ETP - I 39  
SK77428MS-03

<b>SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION</b>	
PART NO.	7U77428-03
SKETCH NO.	SPIDERMS-01
CPI NO.	XXXXXX
CORPORATION SPACE OPERATIONS MANUFACTURING DIVISION DESIGNING	15 OF 36

AFT → ← FWD ↑

TEST AREA # 16



1. APPLY A SMALL PINCH OF WATER SATURATED ASBESTOS AT LOC 1, 2, 3 AND 4.
2. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK holes A..1 cc OF (0.000) TCA) AT LOC 1.
3. holes B..1 cc OF (0.001) TCA) AT LOC 2.
- holes C..1 cc OF (0.01) TCA) AT LOC 3.
- holes D..1 cc OF (0.1) TCA) AT LOC 4.
4. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

\* No additional water added (water was in the asbestos string sample)

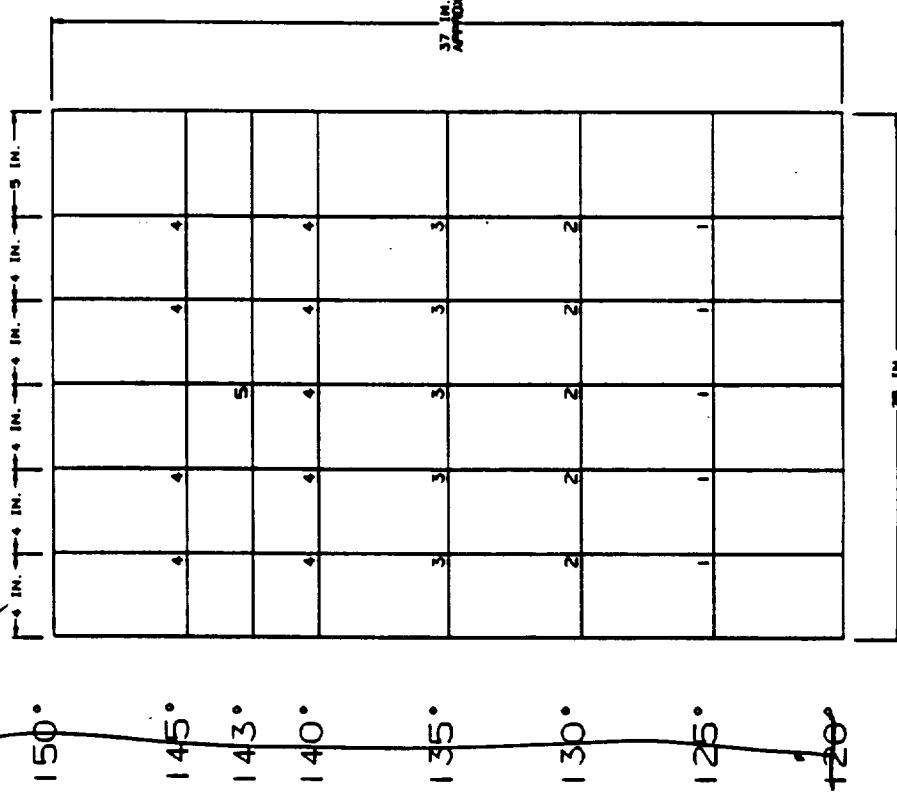
4 ▲ 168 . 3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	7U77428-03	SPACE OPERATIONS MANUFACTURING ENGINEERING	Thickool CORPORATION
SKETCH NO.	SPIDERMS-01	CPI NO.	PAGE
	XXXXXX	XXXXXX	16 OF 36

AFT → ← FWD

TEST AREA # 17



1. APPLY A SMALL PINCH OF WATER SATURATED ASBESTOS AT LOC 1, 2, 3 AND 4.
  2. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  3. AFTER 15 SECONDS, REMOVE NBR FROM CHEMLOK.
  - A. EXAMINE CHEMLOK FOR DEFECTS.
  - B. DOCUMENT DEFECTS ON SKETCH.
  - C. IF NO DEFECTS ARE CREATED, RETRY STEPS 2 AND 3 VARYING TIMES OF NBR ADHESION.
  - D. REAPPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  4. INJECT TCA BETWEEN NBR AND CHEMLOK. ADJUST INJECTION POINT TO CORRESPOND WITH DEFECTS DOCUMENTED IN STEP 3.
- hole A: 1 c.c. OF TCA AT LOC 1, 2 AND 3.  
hole B: 0.5 c.c. OF TCA AT LOC 5.*
5. APPLY SECOND LAYER OF NBR ACTIVATED WITH TCA.

107 in. at 4

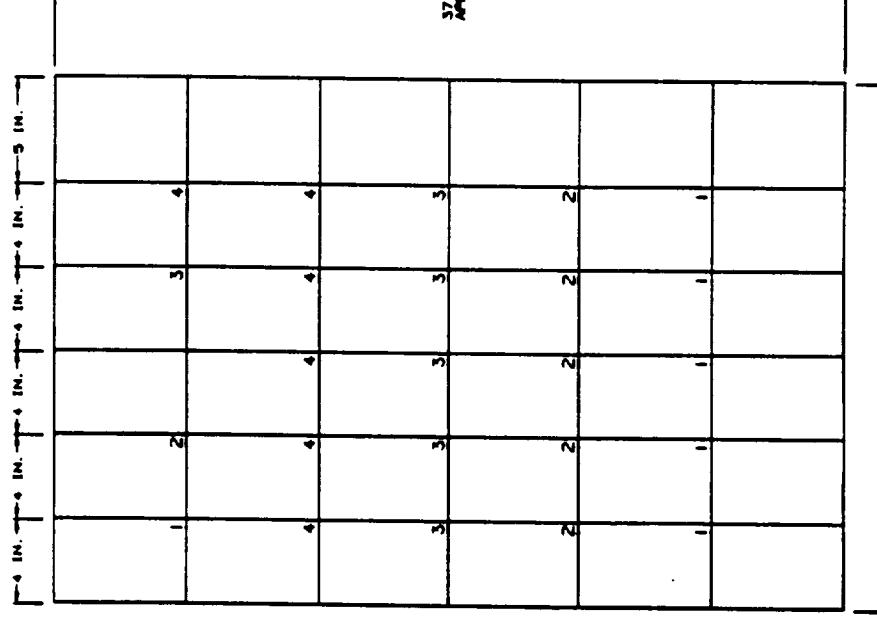
4 ▲ 168. 3-  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	SKETCH NO.	SPIDERMS-01	XXXXXX	17 OF 36
7U77428-03	CPI NO.			

AFT → ← FWD ←

TEST AREA # 18



4  
REF

1. APPLY A SMALL PINCH OF WATER SATURATED ASBESTOS AT LOC 1, 2, 3, AND 4.
2. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
3. AFTER 15 SECONDS, REMOVE NBR FROM CHEMLOK.
4. EXAMINE CHEMLOK FOR DEFECTS.
5. DOCUMENT DEFECTS ON SKETCH.
6. IF NO DEFECTS ARE CREATED, RETRY STEPS 1 AND 2 VARYING TIMES OF NBR ADHESION.
7. REAPPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
8. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK. ADJUST INJECTION POINT TO CORRESPOND WITH DEFECTS DOCUMENTED IN STEP 3.

*holes A. • 1 cc of (0.000) WATER: 0.01%  
holes B. • 1 cc of (0.001) WATER: 0.1%  
holes C. • 1 cc of (0.01) WATER: 1%  
holes D. • 1 cc of (0.1) WATER: 10%.*

9. APPLY SECOND LAYER OF NBR ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	<i>Thickol</i> CORPORATION SPACE OPERATIONS MANUFACTURING SOLUTIONS
SKETCH NO.	7U77428-03
CPI NO.	SPIDERMS-01 XXXXX

~~AFT~~ → ~~FWD~~ →

TEST AREA # 19

210°

4 IN. ↑ 4 IN. ↑ 4 IN. ↑ 4 IN. ↑ 3 IN. ↑

205°

200°

195°

190°

185°

180°

4 ▶ 168 . 3 -  
REF

37 IN.  
approx.

28 IN.

1. APPLY BOTH PLYS OF NBR  
ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

**Thiokol** CORPORATION  
SPACE OPERATIONS CAD/CAM  
MAP ACTUATOR DESIGN

PART NO. 7U77428-03 SKETCH NO. CPI NO. PAGE

SPIDERMS-01 XXXXXX 19 OF 36

2 in. 2 yr., 1900 on #8

~~AFT → ← FWD~~

IN. T-4 IN. T-4 IN. T-4 IN. T-4 IN. T-5 IN. T-5 IN.

240°

TEST AREA # 20

TEST AREA # 20

1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  2. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK.

opz A. .| cc OF (0.000) WATER :  
 opz B. .| cc OF (0.000) WATER :  
 opz C. .| cc OF (0.01) WATER :  
 opz D. .| cc OF (0.1) WATER :  
 opz E. .| cc OF (1.0) WATER :

  3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

in chalk visible through hole in rubber  
cover of defect in chalklet visible through  
hole in rubber

only

lin overlap on #8

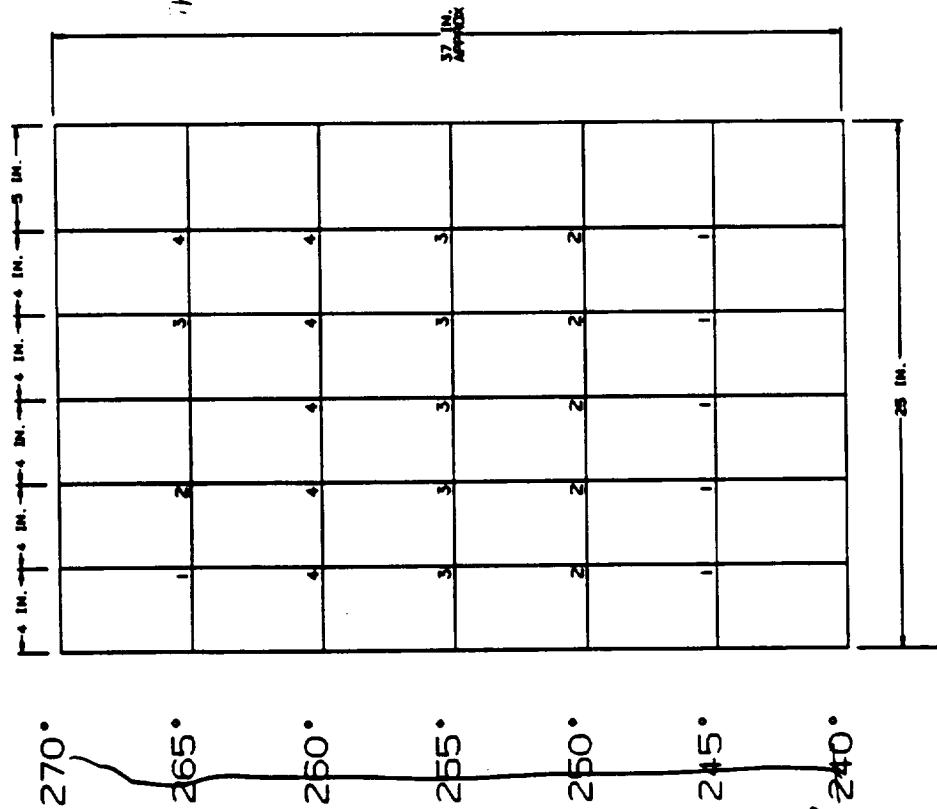
REF

ETP - 1139  
SK77428MS-03

SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION			
PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77428-03			

**AFT** ←FWD→

TEST AREA # 21



168.3  
REF

上

ETP - I-39  
SK 77428MS-0

PART NO.		CORPORATION	
7U77428-03		CAD/CAM	
SKETCH NO.		PAGE	
SPIDERMS-01	CPI NO.	21	OF 36

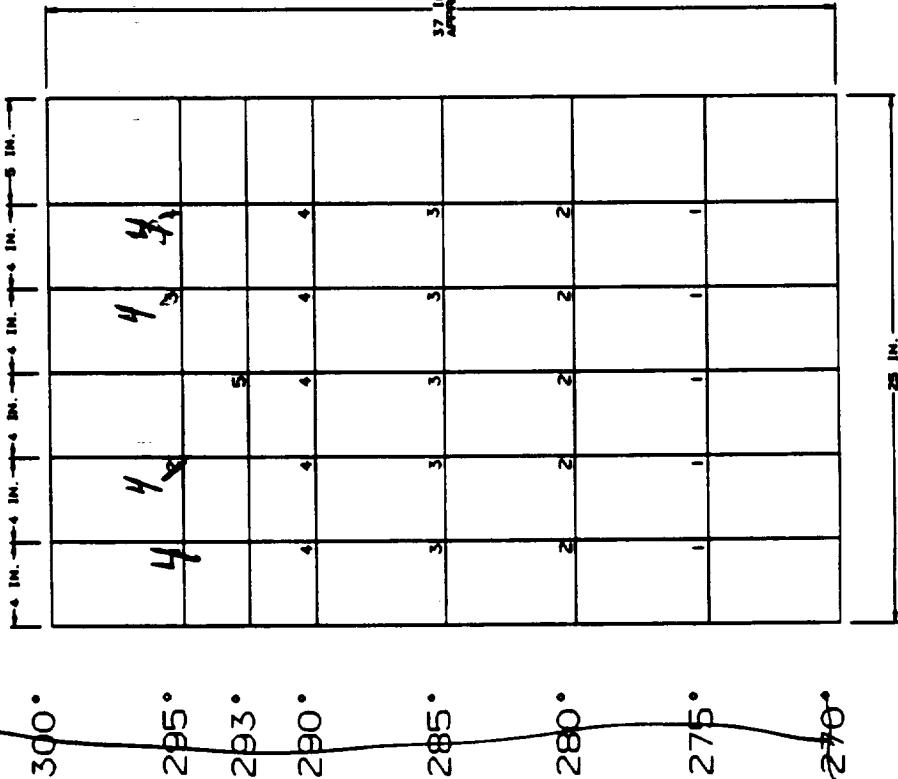
卷之三

SPIDERMS-01 21 OF 36

36

$\leftarrow$  AFT  $\rightarrow$  FWD  $\leftarrow$

TEST AREA # 22



168.3  
REF

REFERENCE DOCUMENTS: ETP - I-39  
SK77428MS-03

TEST AREA # 23

1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  2. AFTER 15 SECONDS, REMOVE NBR FROM CHEMLOK.
    - A. EXAMINE CHEMLOK FOR DEFECTS.
    - B. DOCUMENT DEFECTS ON SKETCH.
    - C. IF NO DEFECTS ARE CREATED, RETRY STEPS 1 AND 2 VARYING TIMES OF NBR ADHESION.
    - D. REAPPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  3. INJECT 1 cc OF SIMULATED SWEAT (ASTM D-1141 SUB OCEAN WATER PH ADJUSTED TO 5.0±0.5 WITH HCL) AT LOC 1 AND 3.
  4. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK. ADJUST INJECTION POINT TO CORRESPOND WITH DEFECTS DOCUMENTED IN STEP 2.
    - A. 1 cc OF (0.001) WATER : TCA) AT LOC 1.
    - B. 1 cc OF (0.001) WATER : TCA) AT LOC 2.
    - C. 1 cc OF (0.001) WATER : TCA) AT LOC 3.
    - D. 1 cc OF (0.001) WATER : TCA) AT LOC 4.
  5. APPLY SECOND LAYER OF NBR ACTIVATED WITH TCA.

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03



4. *isolated effect*

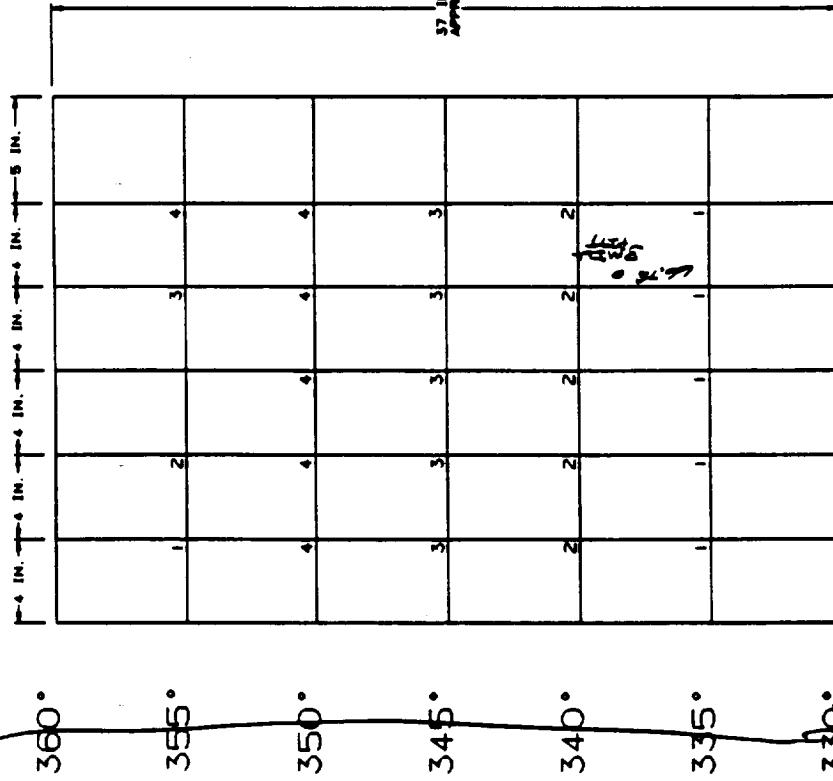
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- REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-0

PART NO.	<b>7U77428-03</b>	THOKOL CORPORATION SPACE OPERATIONS MANUFACTURING DIVISION	PAGE
SKETCH NO.	CPI NO.	XXXXXX	23 OF 36

AFT → ← FWD

TEST AREA # 24



4 168.3  
REF

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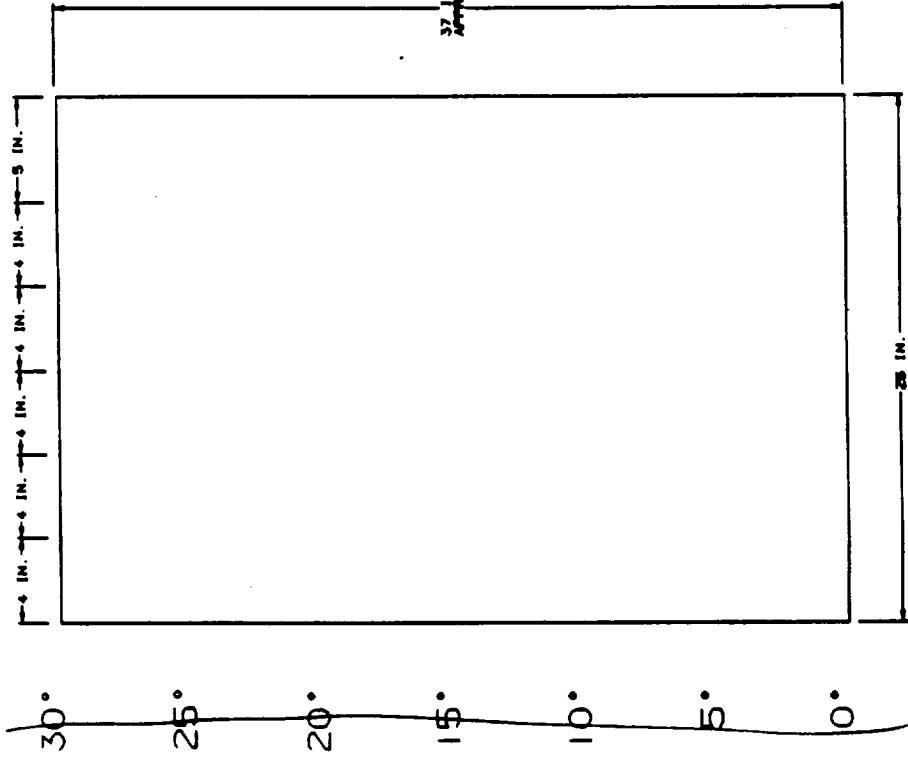
1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  2. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK.
  3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.
- H<sub>2</sub>O*
- TCA* A.
- holes B. c. OF (0.000) WATER :  
TCA) AT LOC 1.
- holes C. c. OF (0.01) WATER :  
TCA) AT LOC 2.
- holes D. c. OF (0.01) WATER :  
TCA) AT LOC 3.
- J. U.*

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	<i>Thokol</i> CORPORATION SPACE OPERATIONS Manufacturing Division
SKETCH NO.	7U77428-03
CPI NO.	XXXXXX

AFT → ← FWD

TEST AREA # 25



4  
REF

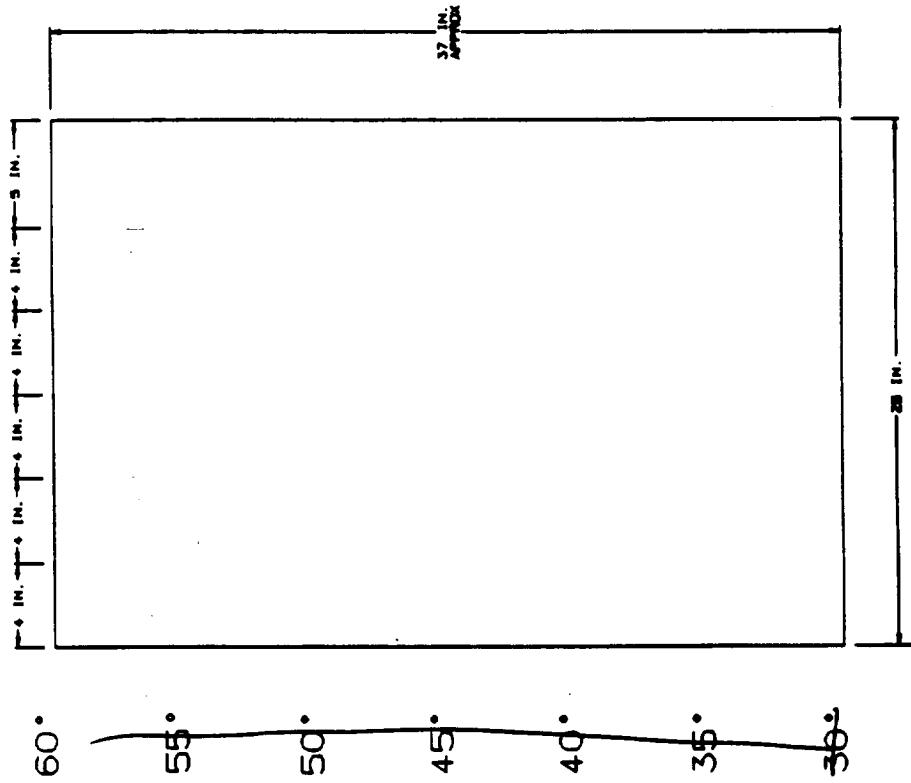
193. 3

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.		Thiokol CORPORATION	
SKETCH NO.		SPACE OPERATIONS MS-28M Series C&D/CAM	
CPI NO.		PAGE	
7U77428-03			
SPIDERMS-01	X XXXXX	25 OF 36	
ANAL. BY CAD/CAM NO. 1012	SPIDER		
SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION			

AFT → ← FWD

TEST AREA # 26



1. APPLY BOTH PLYS OF NBR  
ACTIVATED WITH TCA.

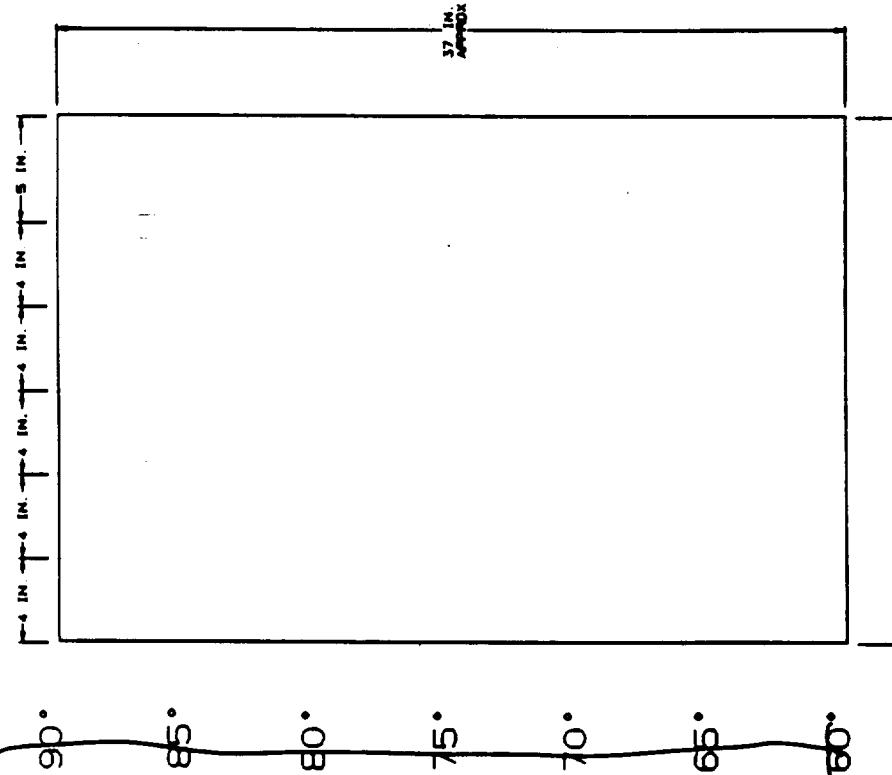
4 193.3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77428-03			
SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION SPIDERMS-01 XXXXXX			

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TEST AREA # 27



4 193.3  
REF

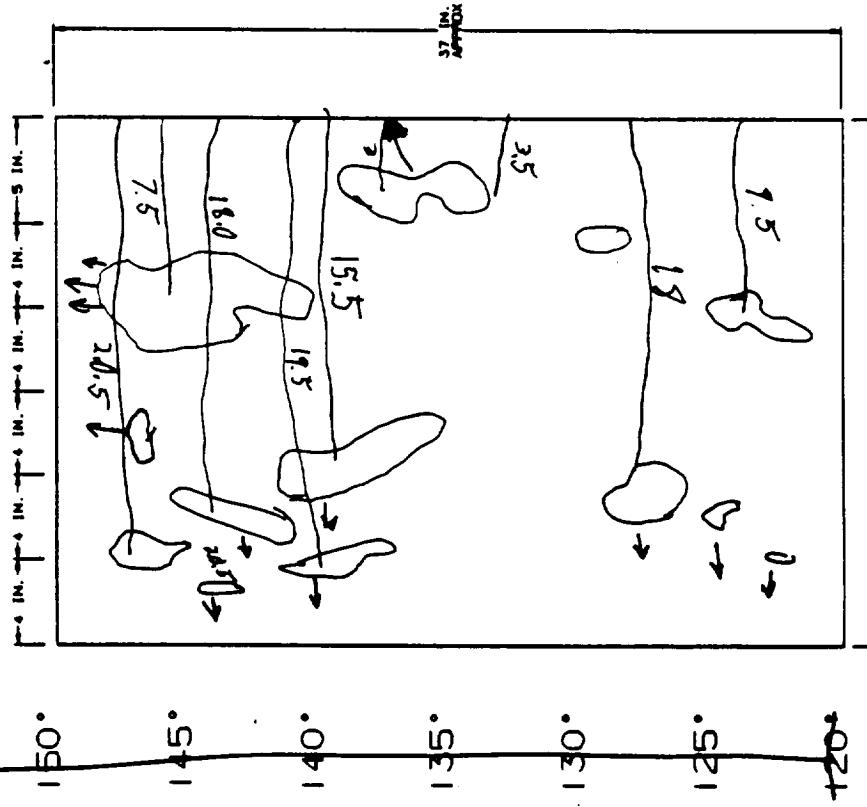
REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	SKETCH NO.	CP1 NO.	PAGE
7U77428-03	SPIDERMS-01	XXXXXX	27 OF 36



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TEST AREA # 29



4 193.3 REF 11 6197C

REFERENCE DOCUMENTS: ETP - I 39  
SK77428MS-03

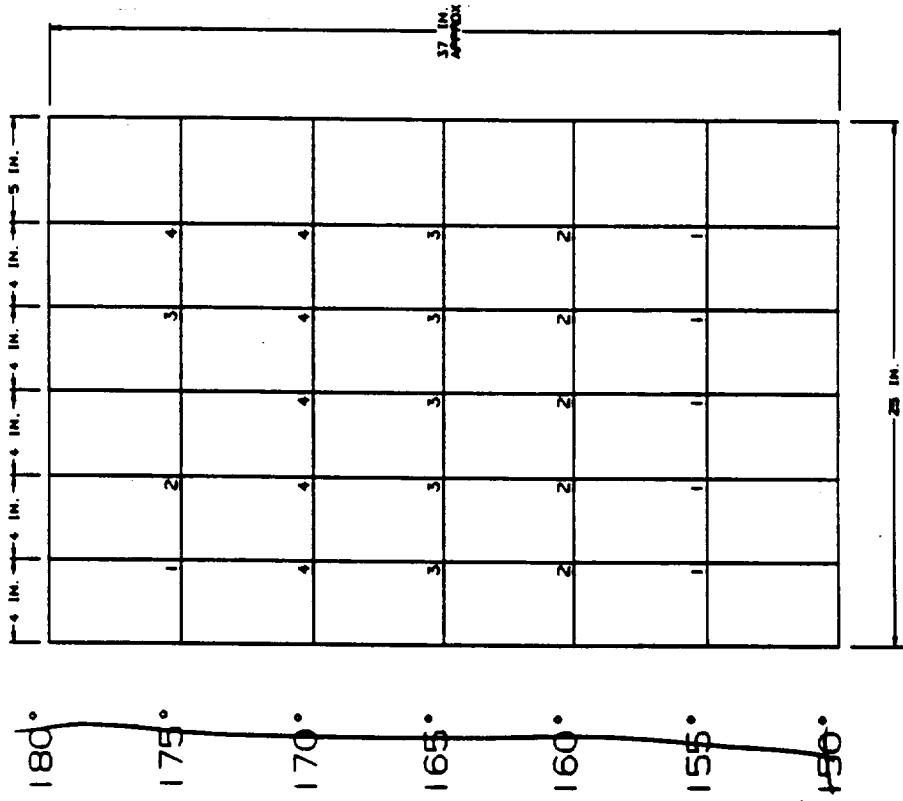
**Thickol** CORPORATION  
AD/CAM  
SPACE OPERATIONS  
DIVISION  
PART NO. 711774-28-03

ANALYSIS OF CAV/CAN HOLE SPACER

SKETCH SHEET SHOP TRAVELER/OPERATION INSTRUCTION

AFT → ← FWD

TEST AREA # 30



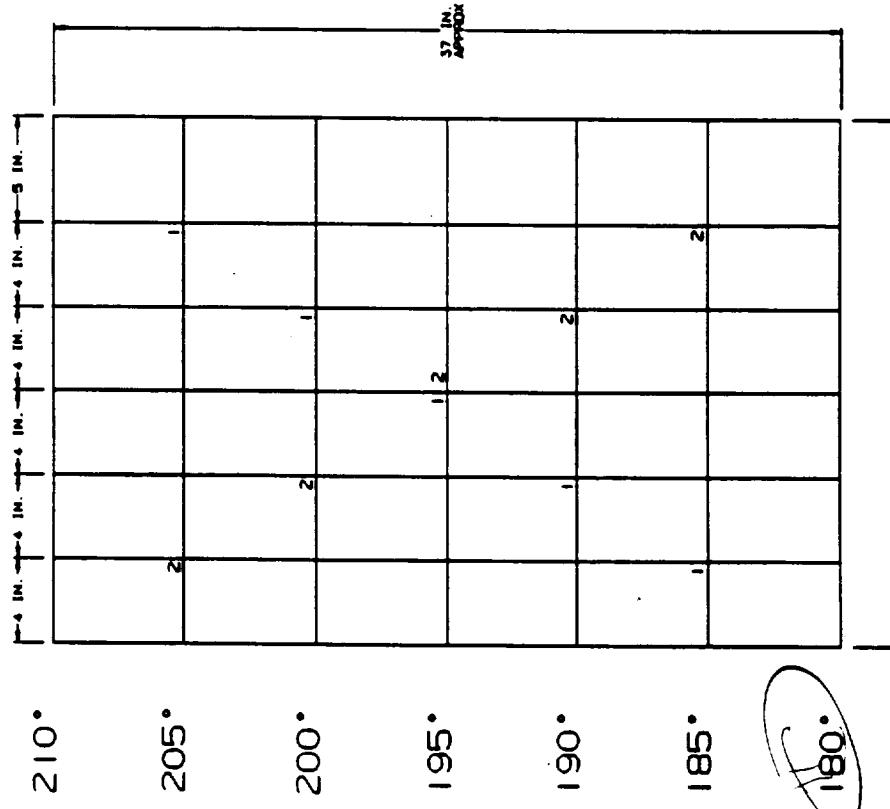
193 . 3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	7U77428-03	SKETCH NO.	SPIDERMS-01	CPI NO.	XXXXXXXX	PAGE
Thickol CORPORATION SPACE OPERATIONS Manufacturing Division Inc	SK 77428MS-03				30 OF 36	

~~AFT~~ ← FWD →

TEST AREA # 31



Grease not noticed under chimney

37

160

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193.3  
REF  
4

REFERENCE DOCUMENTS: ETP - I-139  
SK77428MS-03

**Thiokol** CORPORATION  
Space Operations CAD/CAM

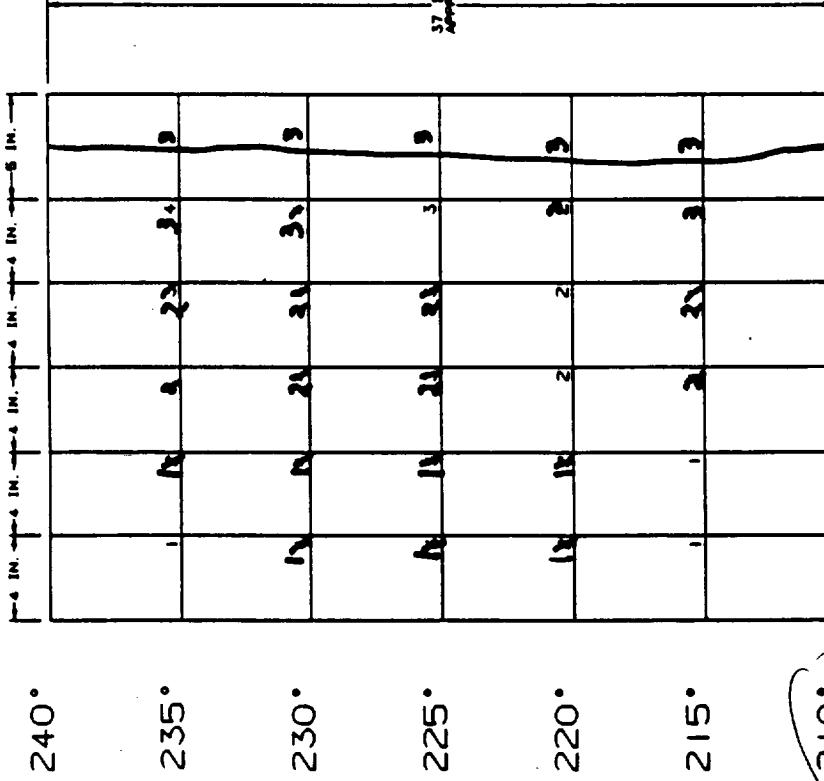
ANALYSIS OF CHOCOLATE MELTS

## **SKETCH SHEET SHOP TRAVELER/OPERATION**

PART NO.	<i>Thickol</i> 7U77428-03	CORPORATION SPACE OPERATIONS MANUFACTURING	CAD/CAM	PAGE
SKETCH NO.	SPIDERMS-01	CPI NO.		31 JF 36
		XXXXXX		

AFT → ← FWD

TEST AREA # 32



240°

235°

230°

225°

220°

215°

4 193.3  
REF

1. PLACE PROVIDED METAL SHAVINGS AT LOCATIONS 1, 2, 3 AND 4.
2. APPLY BOTH PLYS OF NBR ACTIVATED WITH TCA.

1. mild steel

2. Aluminum

3. Metal shavings

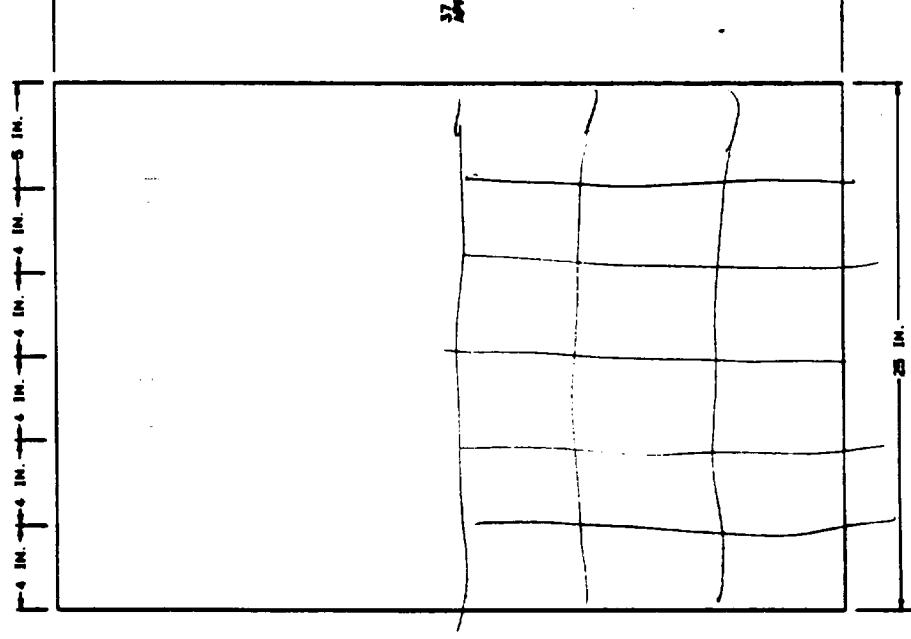
REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	7U77428-03		7U77428-03	7U77428-03
SKETCH NO.	CP1 NO.		CP1 NO.	CP1 NO.
ANNEL IN CAD/CAM MODEL	SPIDER	SPIDER	SPIDER	SPIDER
SKETCH SHEET	SHOP TRAVLER/OPERATION INSTRUCTION	SPIDERMS-01	SPIDERMS-01	SPIDERMS-01

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TEST AREA # 33



1. APPLY BOTH PLYS OF NBR  
ACTIVATED WITH MEK

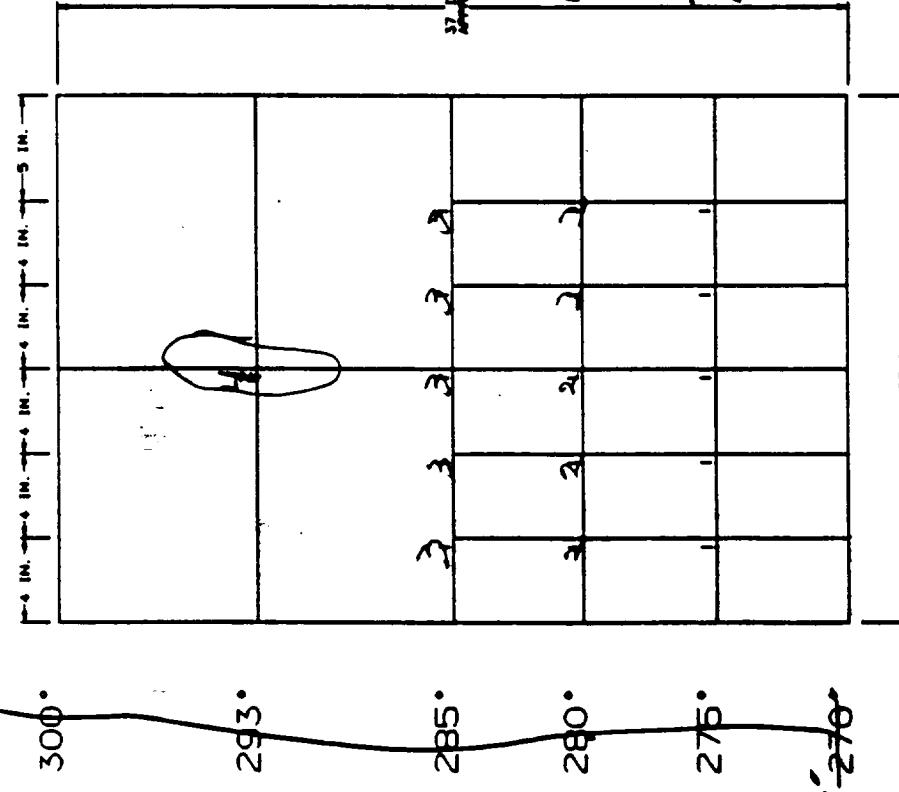
4 ▲ 193.3 REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

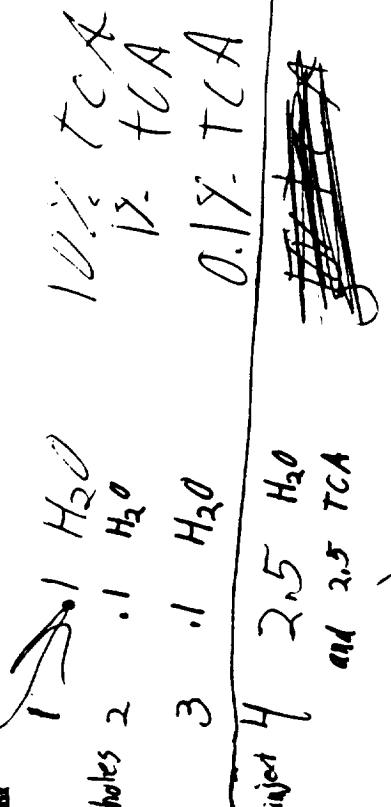
PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77428-03	SPIDERMS-01	XXXXXX	33 OF 36

→ AFT      FWD →

TEST AREA # 34



1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
2. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK.  
5 cc OF (0.01 WATER :  
1 TCA) AT LOC 1  
20 cc OF (0.01 WATER :  
1 TCA) AT LOC 2.
3. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

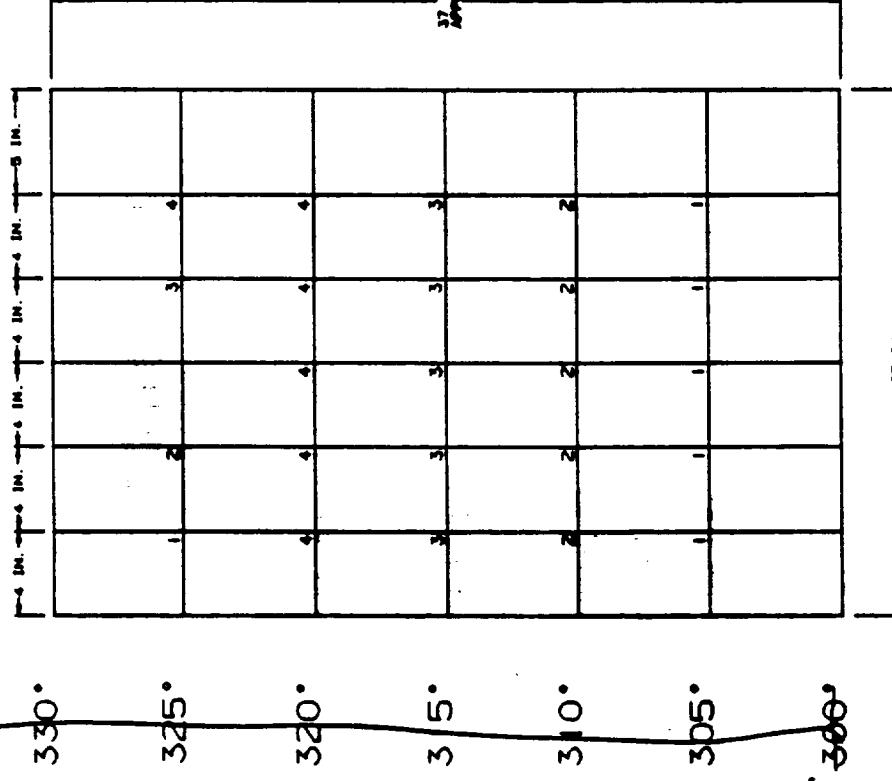


4 193.3 REF

REFERENCE DOCUMENTS: ETP - 1139  
SK 77428MS-03

PART NO.	SKETCH NO.	CP1 NO.	PAGE
<i>Thickool</i> CORPORATION SPACE OPERATIONS CAD/CAM	7U77428-03	XXXXXX	34 OF 36

## TEST AREA # 35



1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
2. AFTER 15 SECONDS, REMOVE NBR FROM CHEMLOK FOR DEFECTS.
  - A: EXAMINE CHEMLOK ON SKETCH.
  - B: DOCUMENT DEFECTS ARE CREATED.
  - C: IF NO DEFECTS ARE CREATED, RETRY STEPS 1 AND 2 VARYING TIMES OF NBR ADHESION.
  - D: REAPPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
3. INJECT TCA/WATER BETWEEN NBR AND CHEMLOK. ADJUST INJECTION POINT TO CORRESPOND WITH holes DOCUMENTED IN STEP 2.  
*(4234A)*
4. APPLY SECOND LAYER OF NBR ACTIVATED WITH TCA.

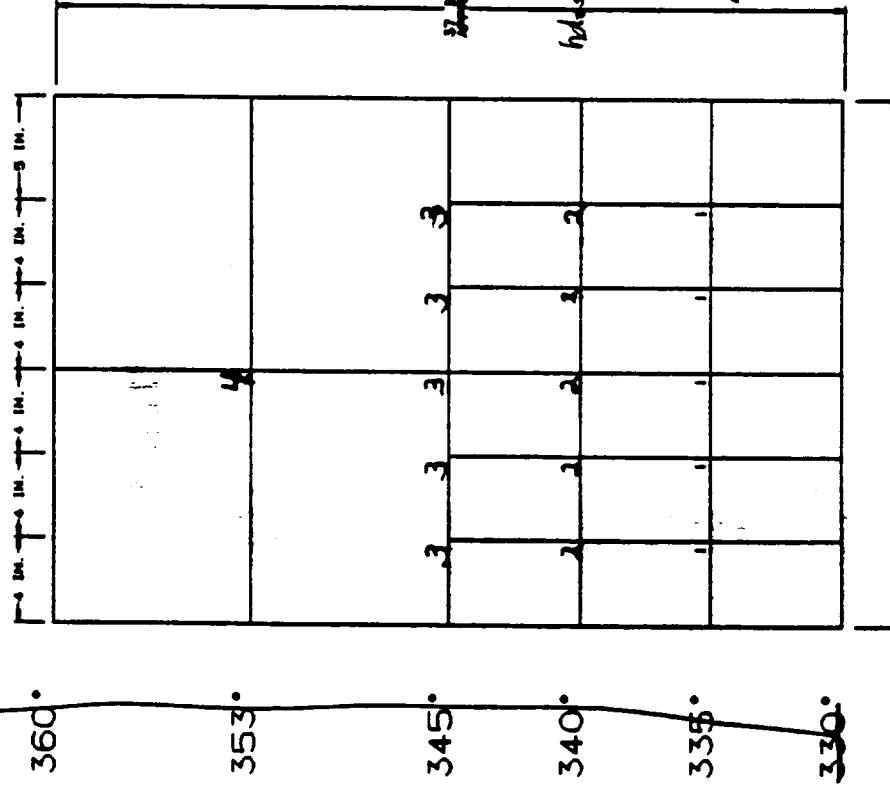
4 193.3  
REF

REFERENCE DOCUMENTS: ETP - 1139  
SK77428MS-03

PART NO.	SKETCH NO.	SPIDERMS-01	XXXXXX	35 OF 36
<b>Thickol</b> CORPORATION SPACE OPERATIONS DIVISION CAD/CAM	7U77428-03	CPI NO.	PAGE	
<b>SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION</b>				

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TEST AREA # 36



193.3  
REF  
4

1. APPLY FIRST PLY OF NBR ACTIVATED WITH TCA.
  2. INJECT TCA BETWEEN NBR AND CHEMLOK.
  3.   5 cc OF TCA AT LOC 1.  
20 cc OF TCA AT LOC 2.
  4. APPLY SECOND PLY OF NBR ACTIVATED WITH TCA.

	$H_2O$	$H_2CO$	$CO_2$	$CH_4$	$Ar$
1.	1	<del><math>H_2CO</math></del>	13%	TCA	
2.	1	$H_2O$	1%	TCA	
3.	1	$H_2O$	0.1%	TCA	

REFERENCE DOCUMENTS: ETP - I-139  
SK77428MS-03

## **SKETCH SHEET TRAVLER/OPERATION**

ANAL. IN CAD/CAM MODELS 33

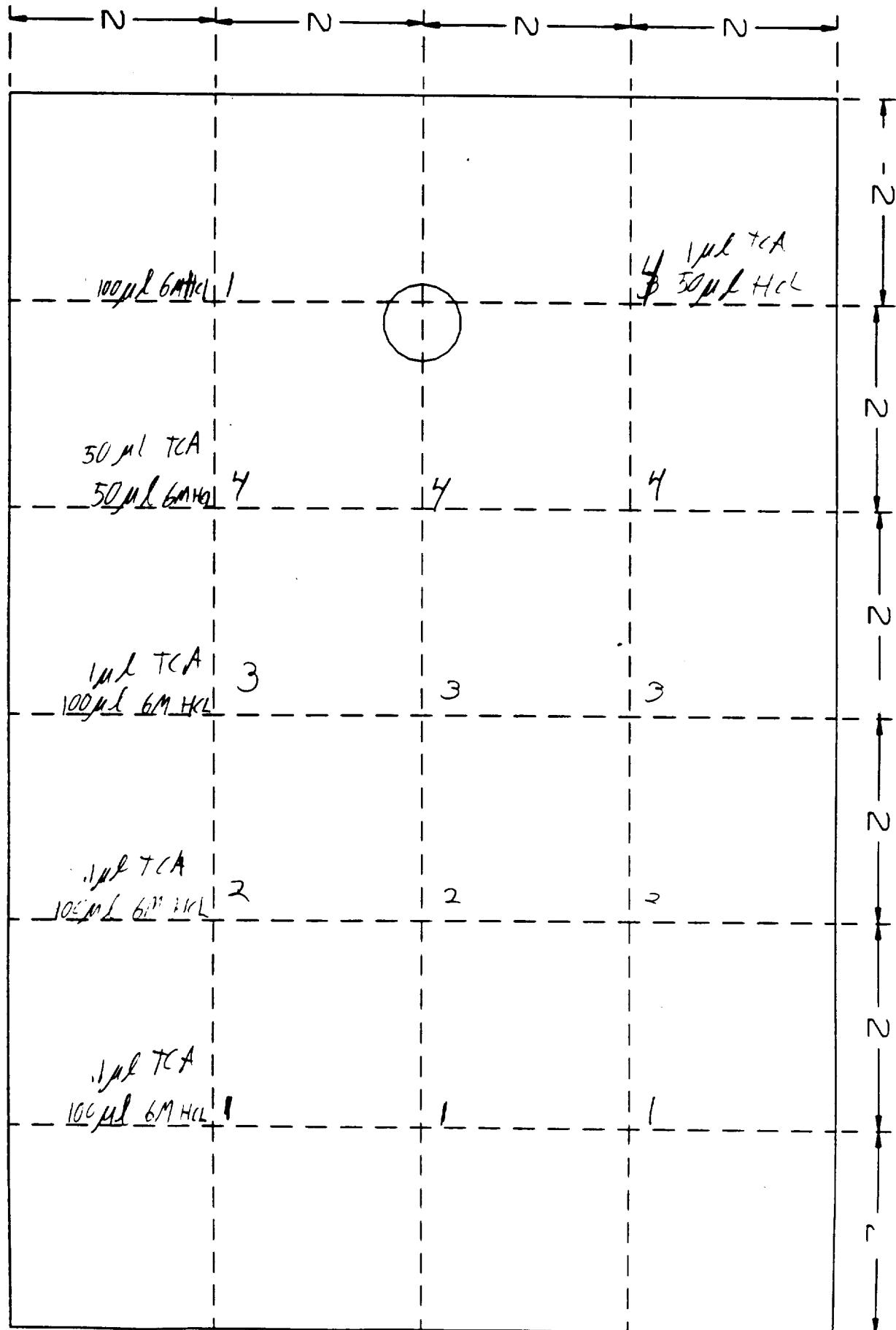
SKETCH SHEET SHOP TRAVLER/OPERATION INSTRUCTION			
PART NO.	SKETCH NO.	CPI NO.	PAGE
7U77428-03	SPIDERMS-01	XXXXXX	36 OF 36

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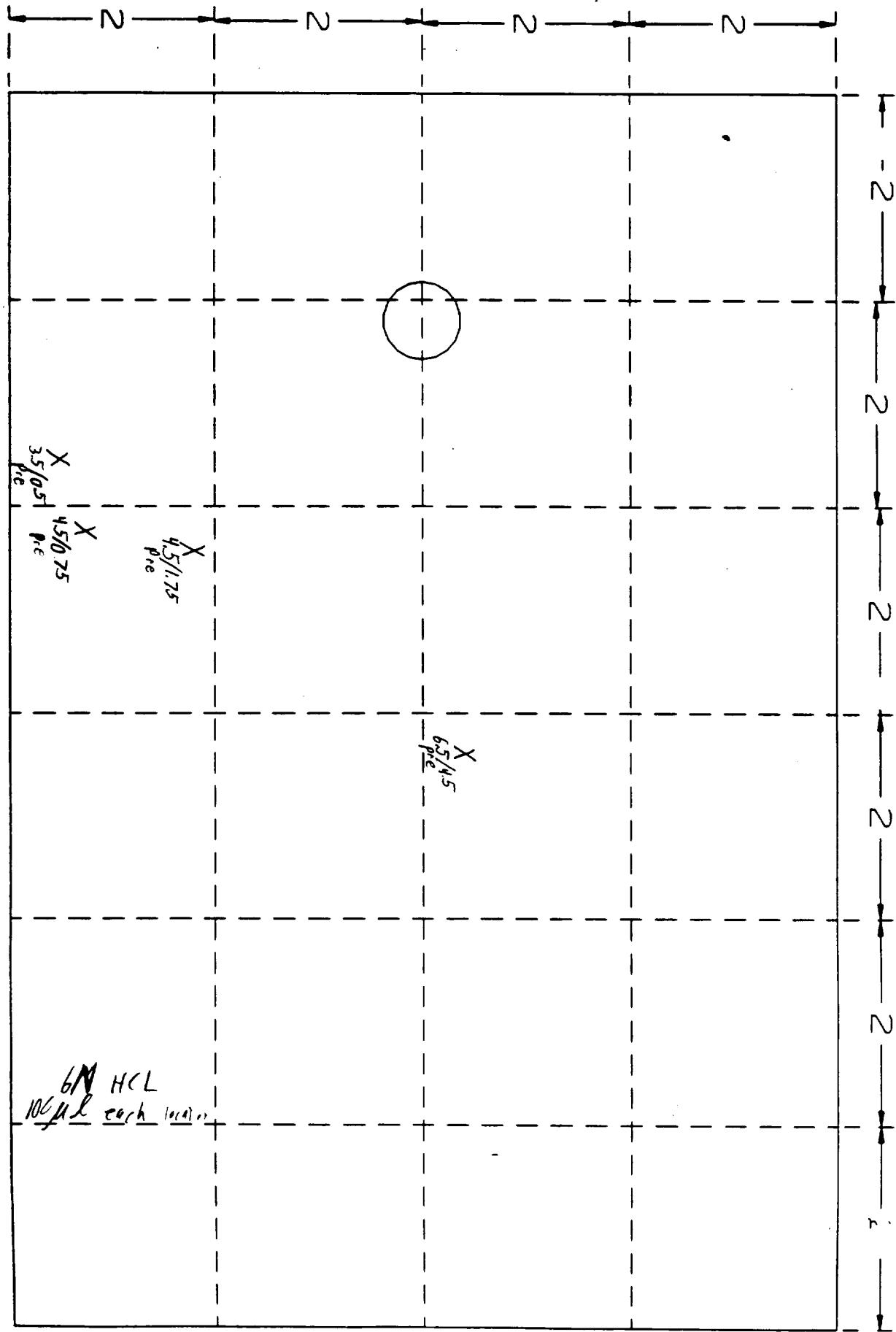
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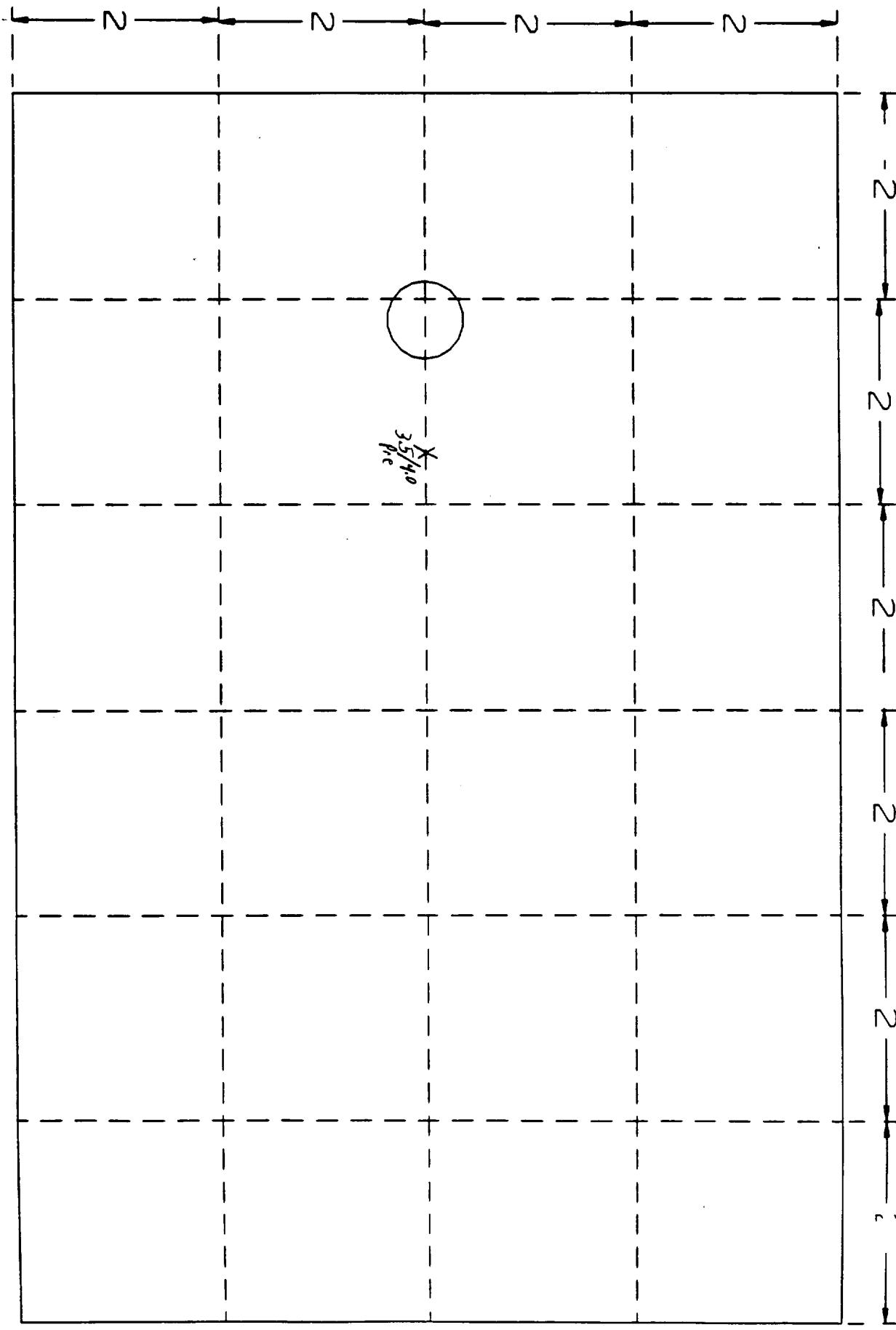


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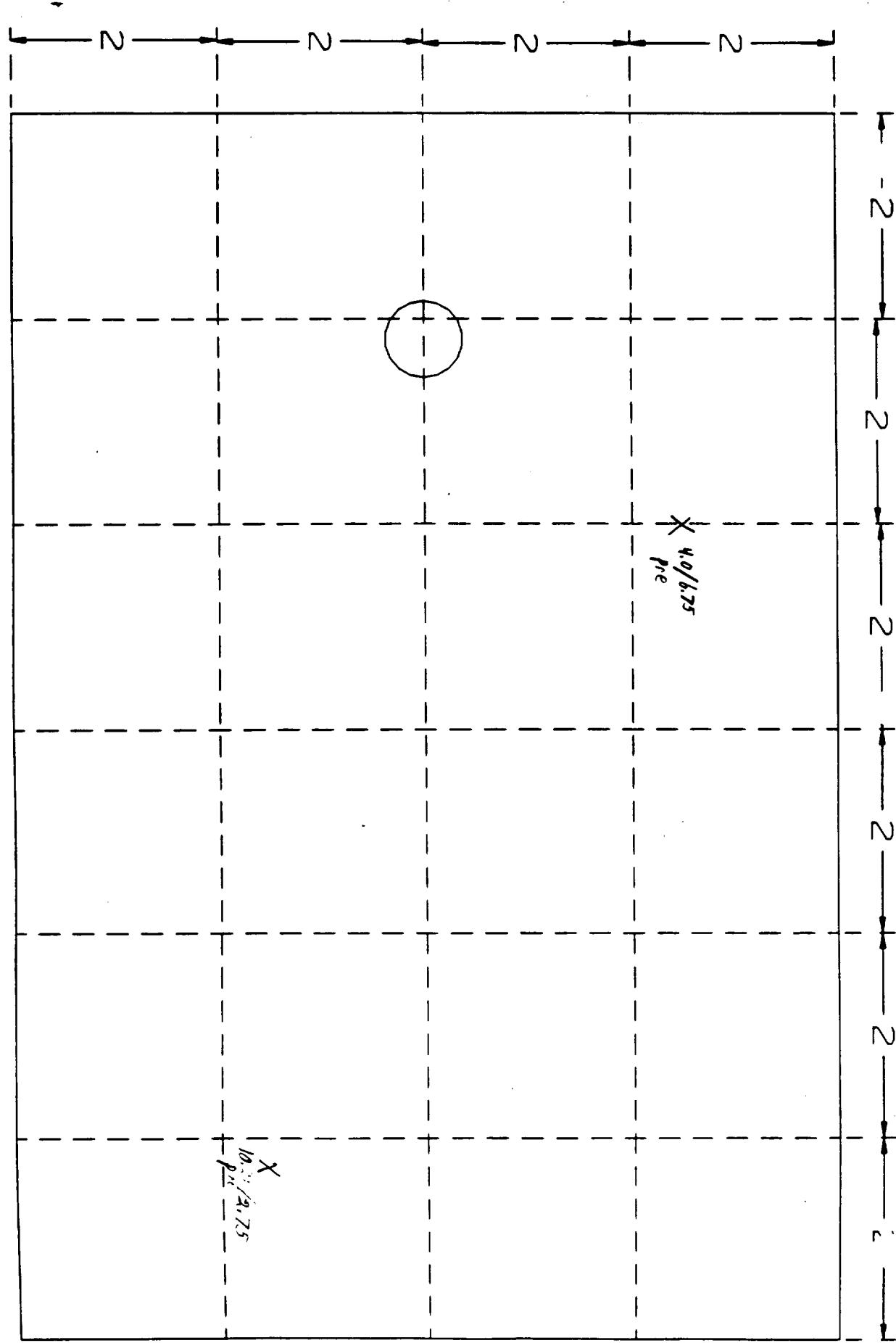
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S/N 8424

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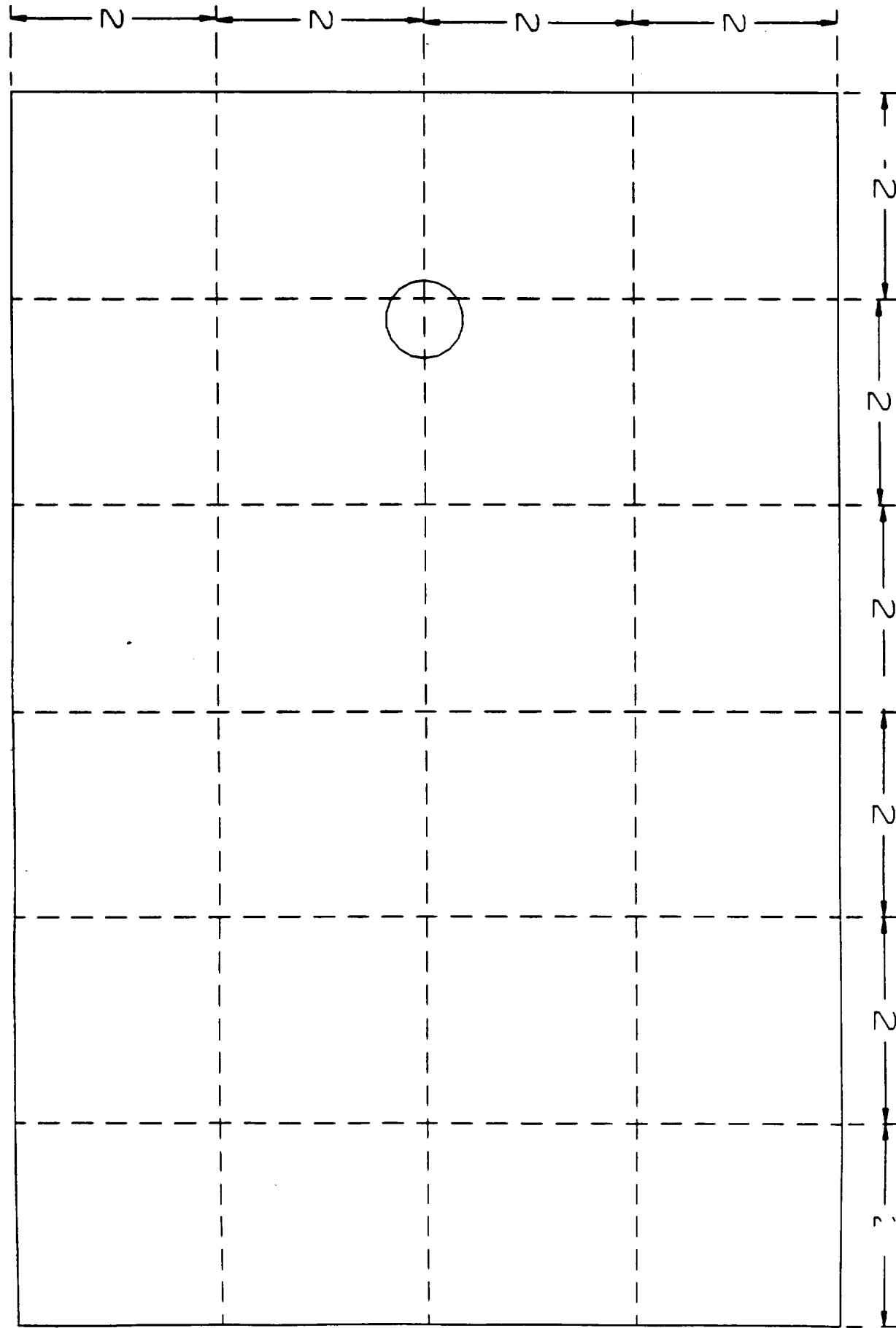
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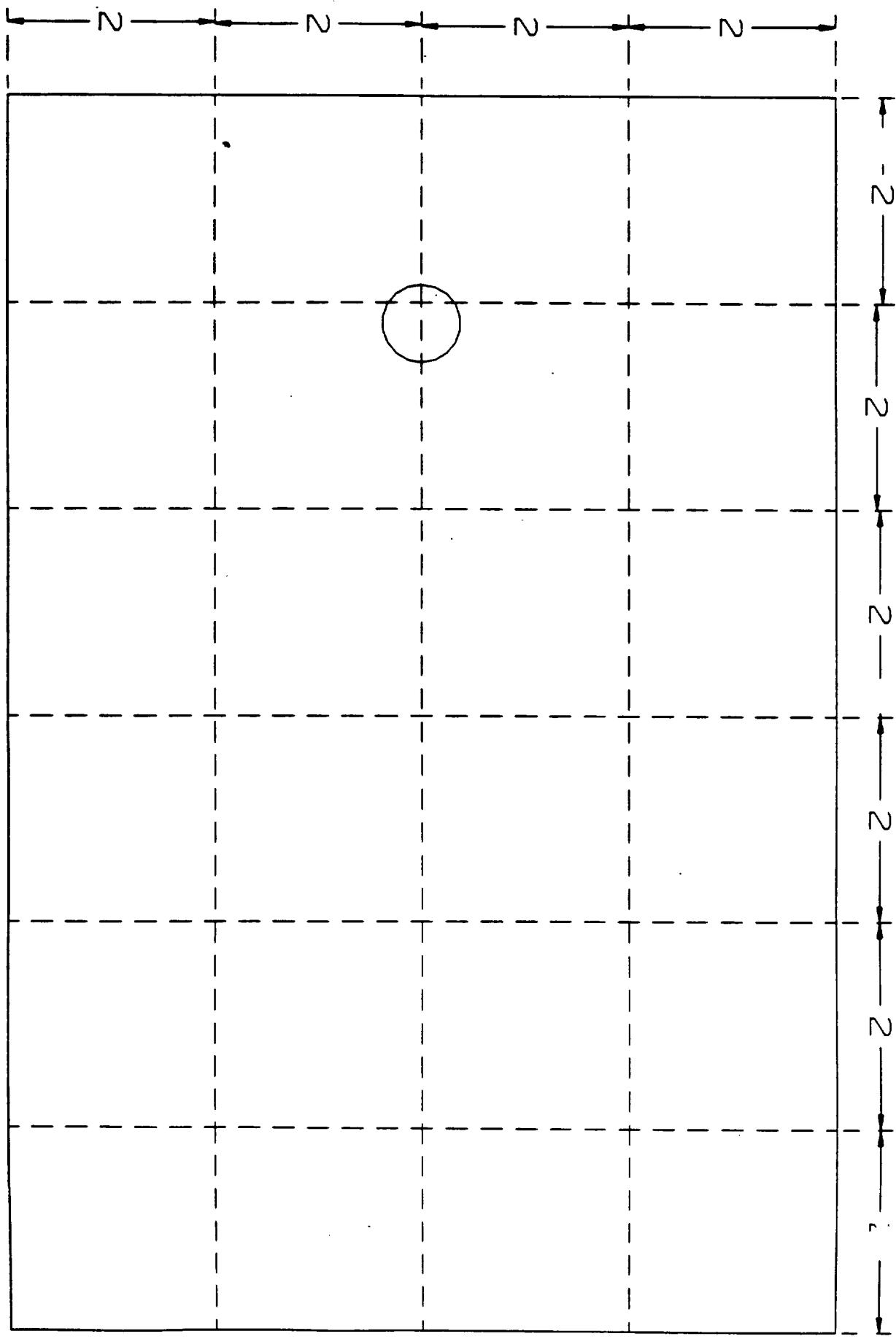
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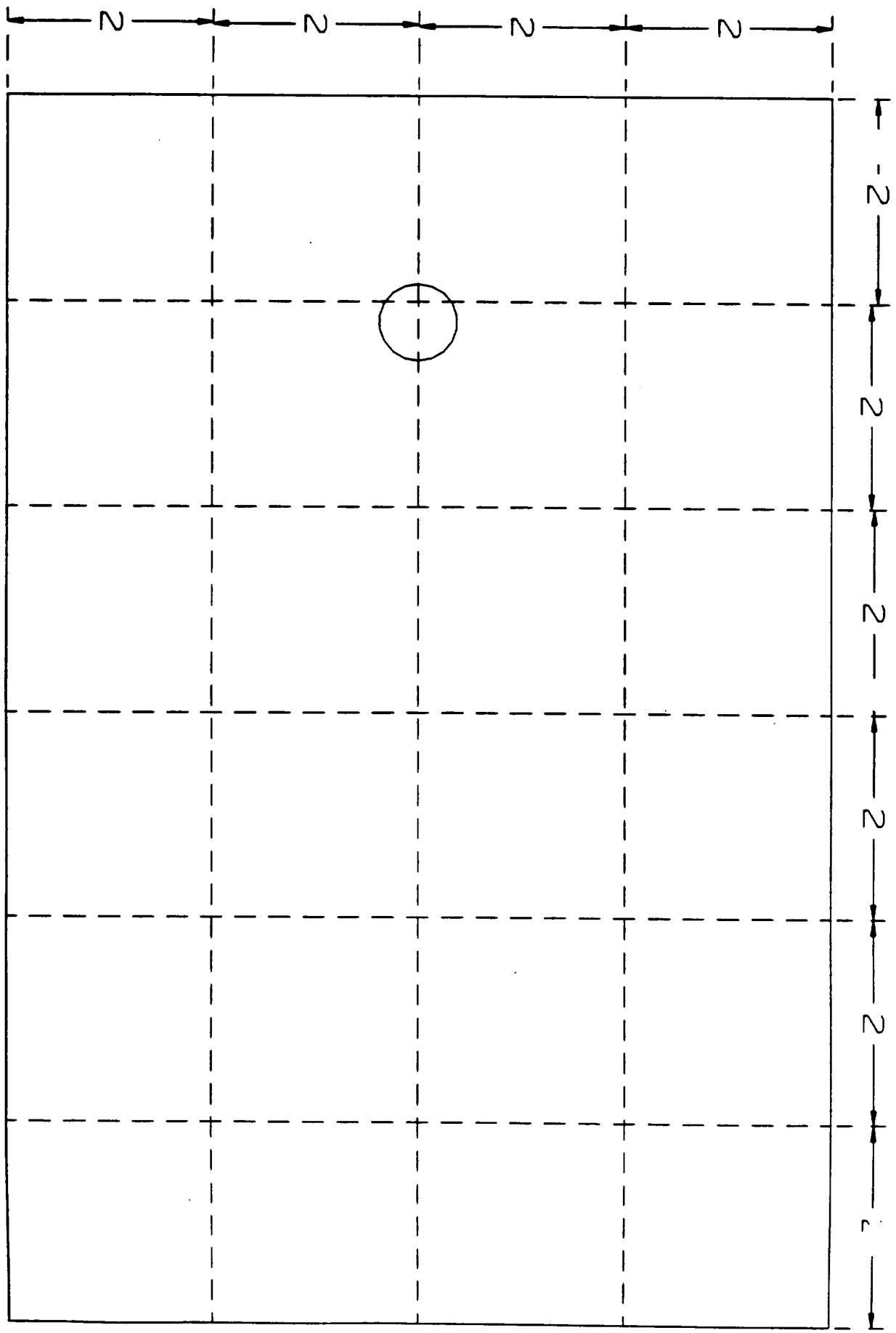
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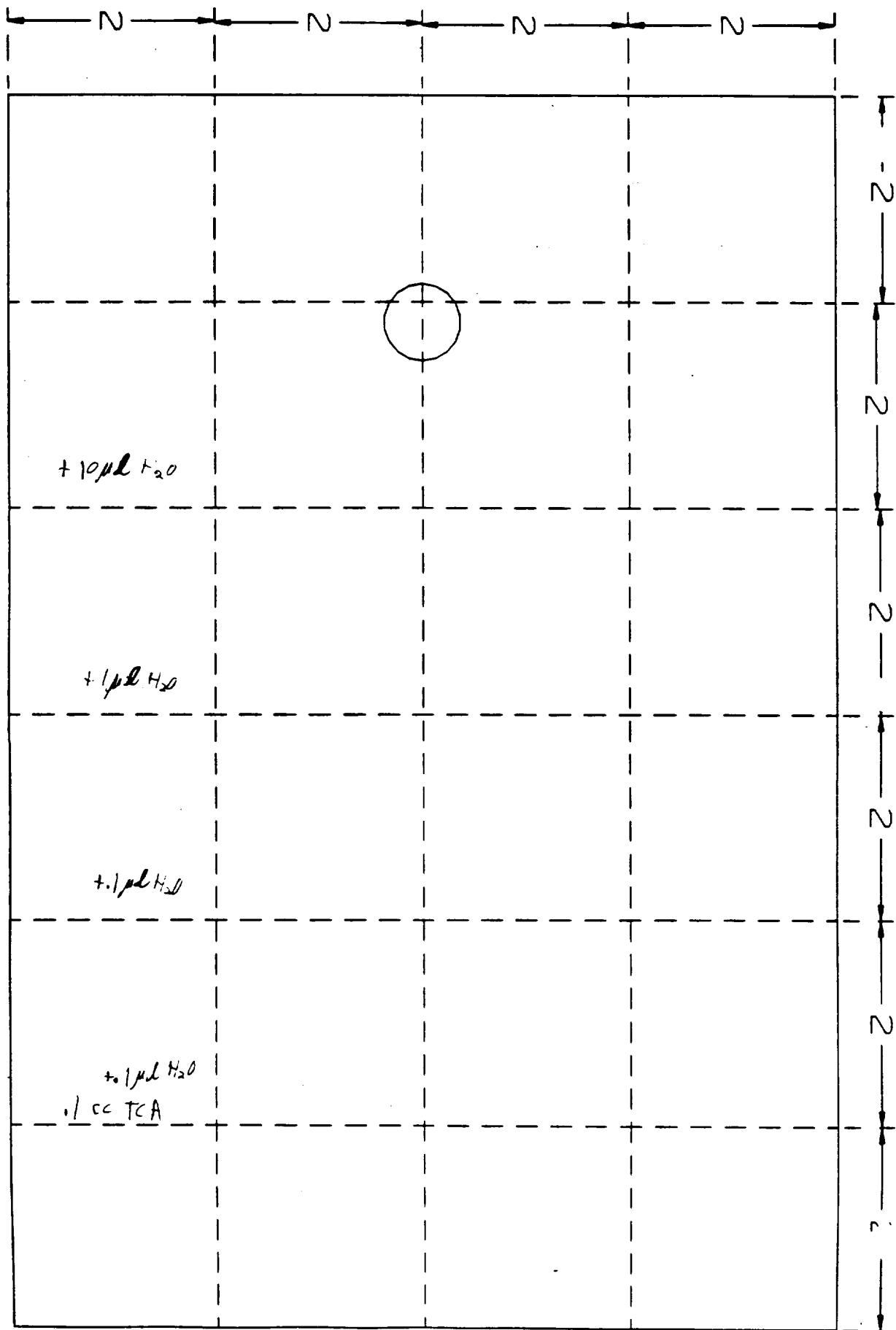
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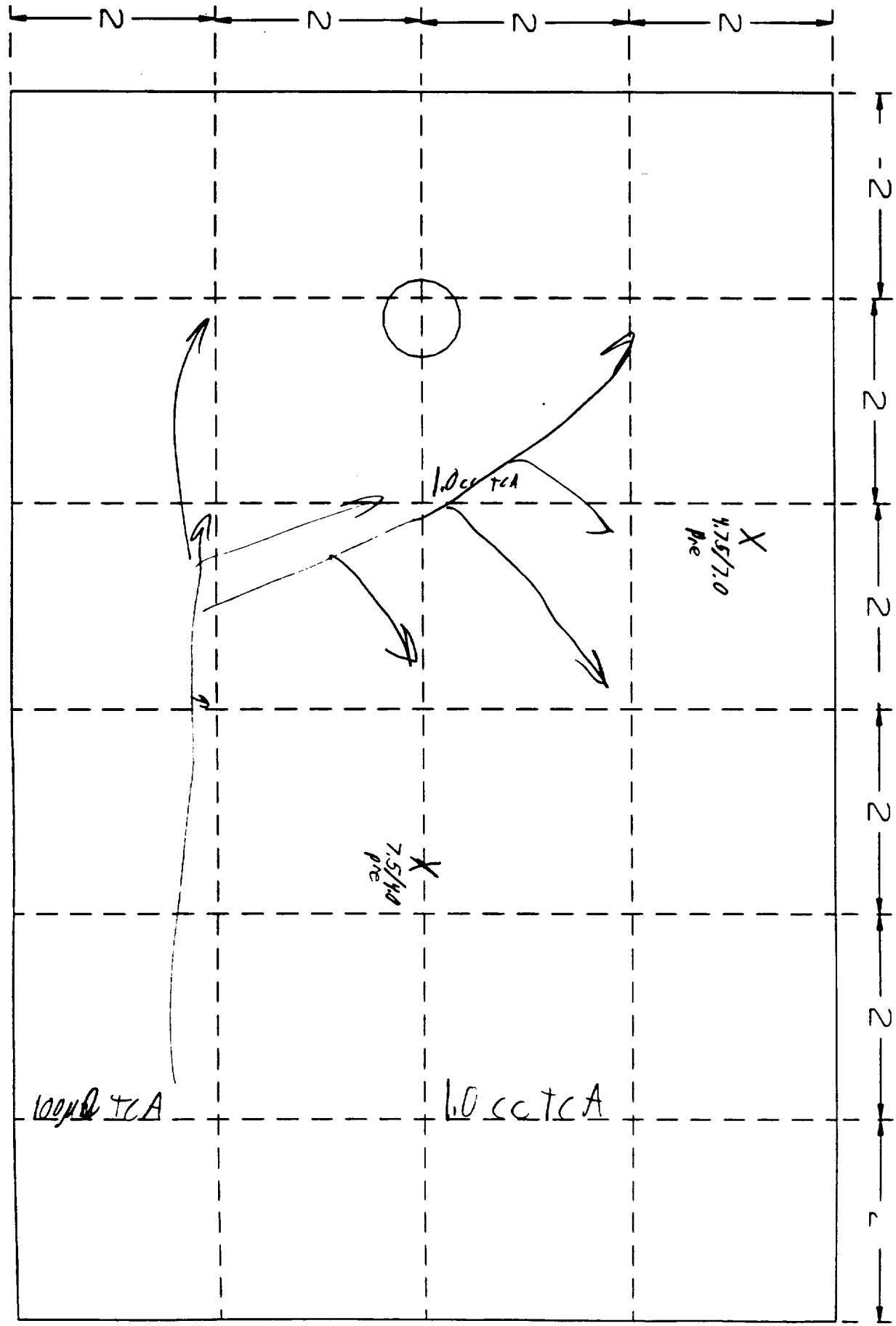
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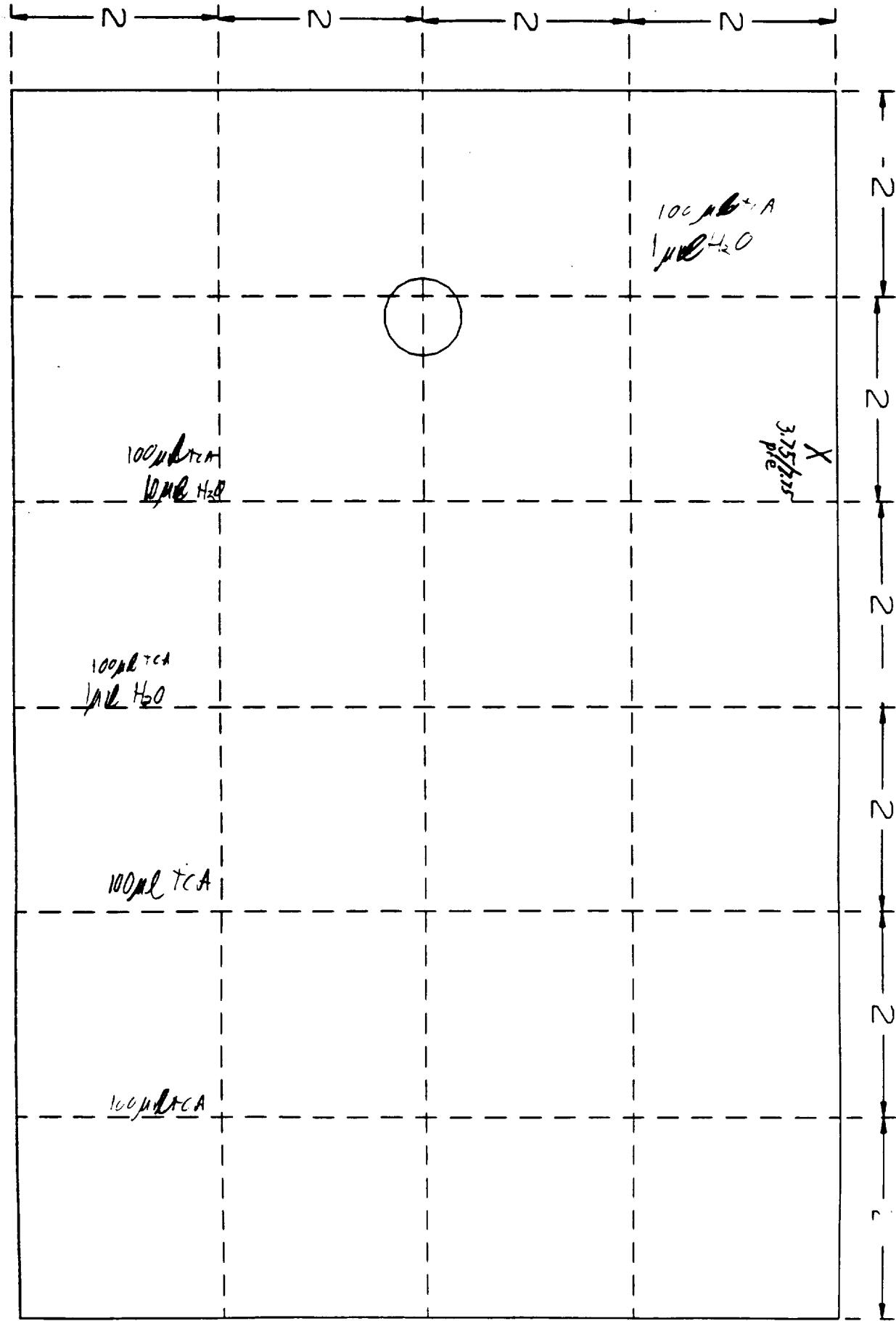
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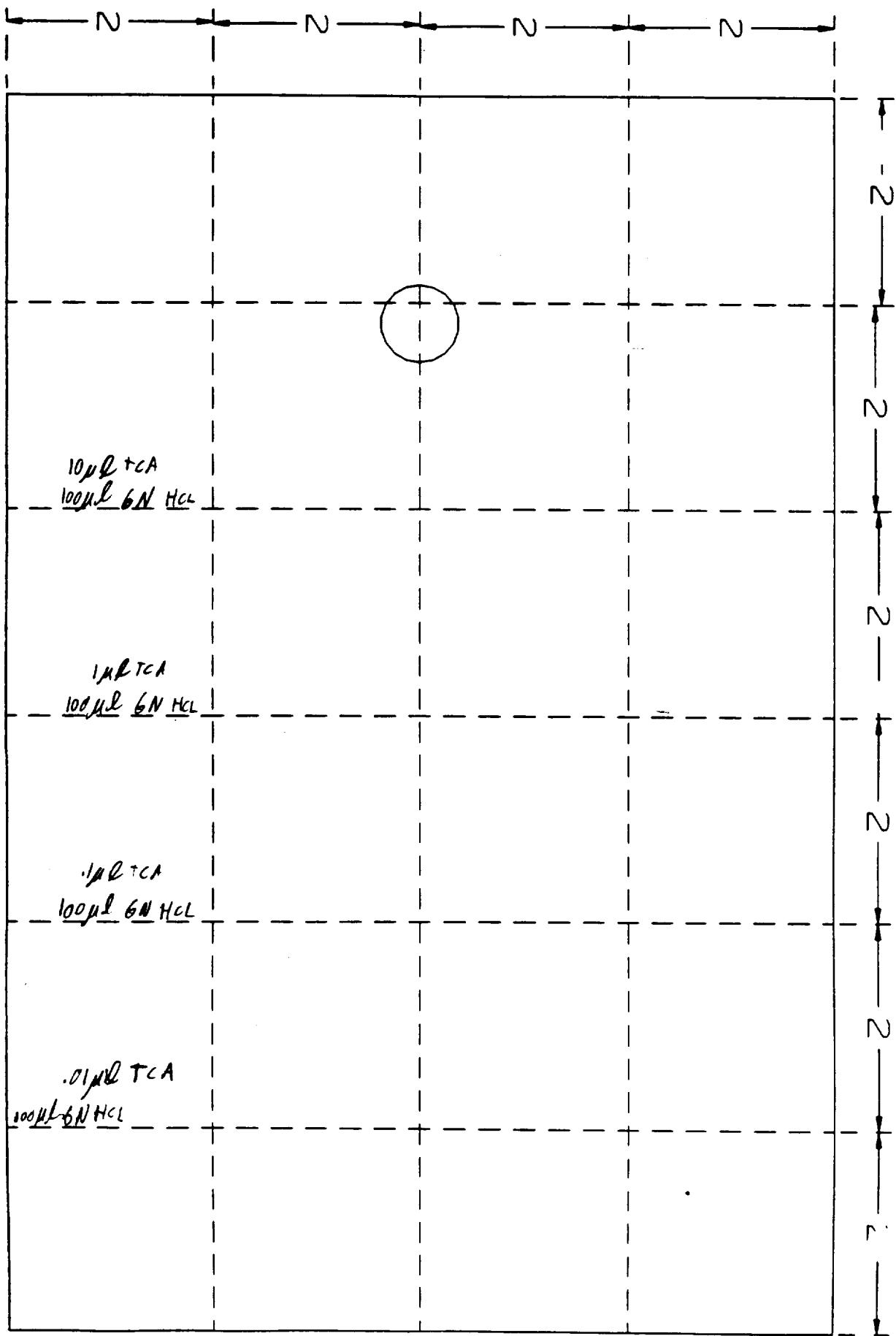
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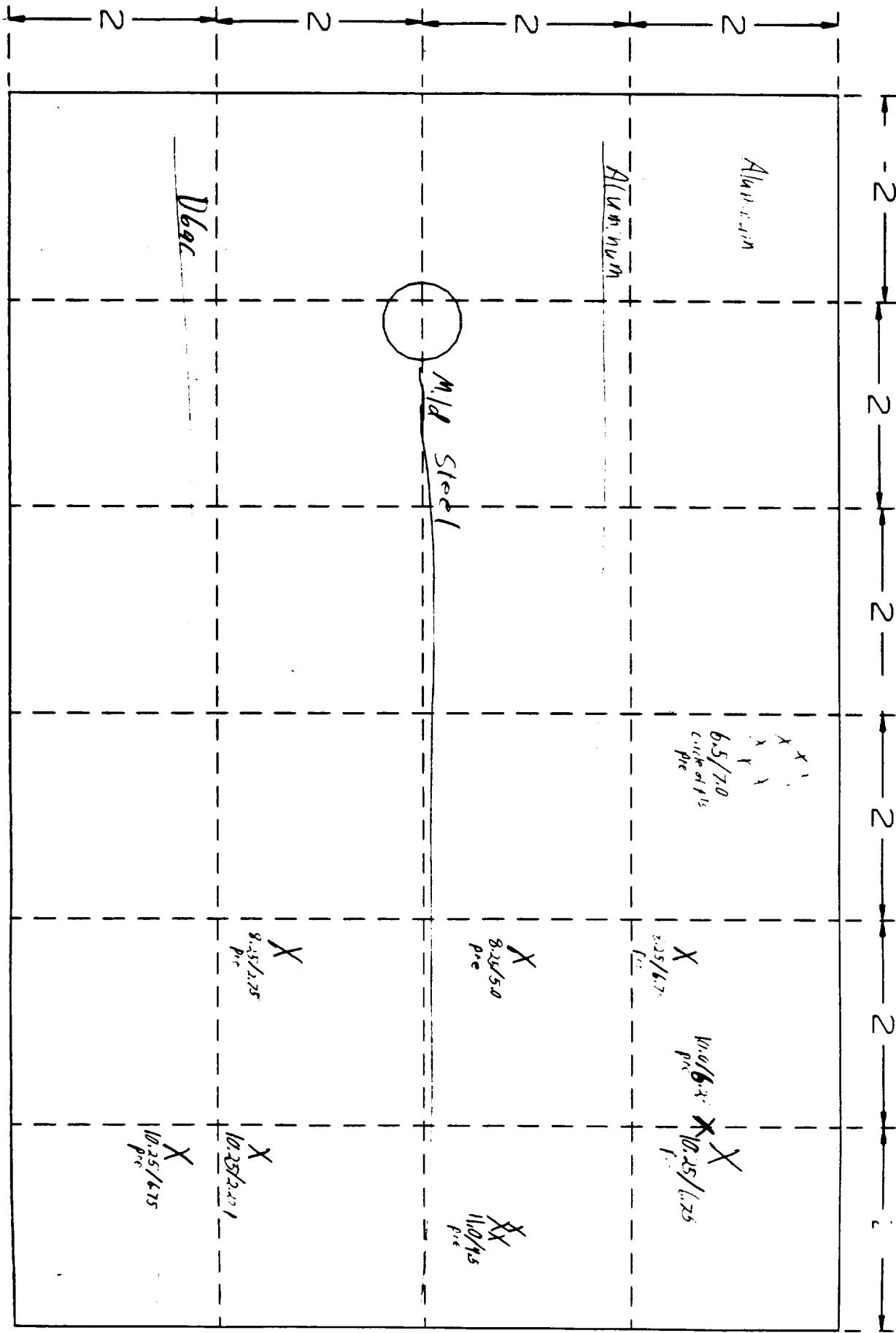


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TEST NO. 12

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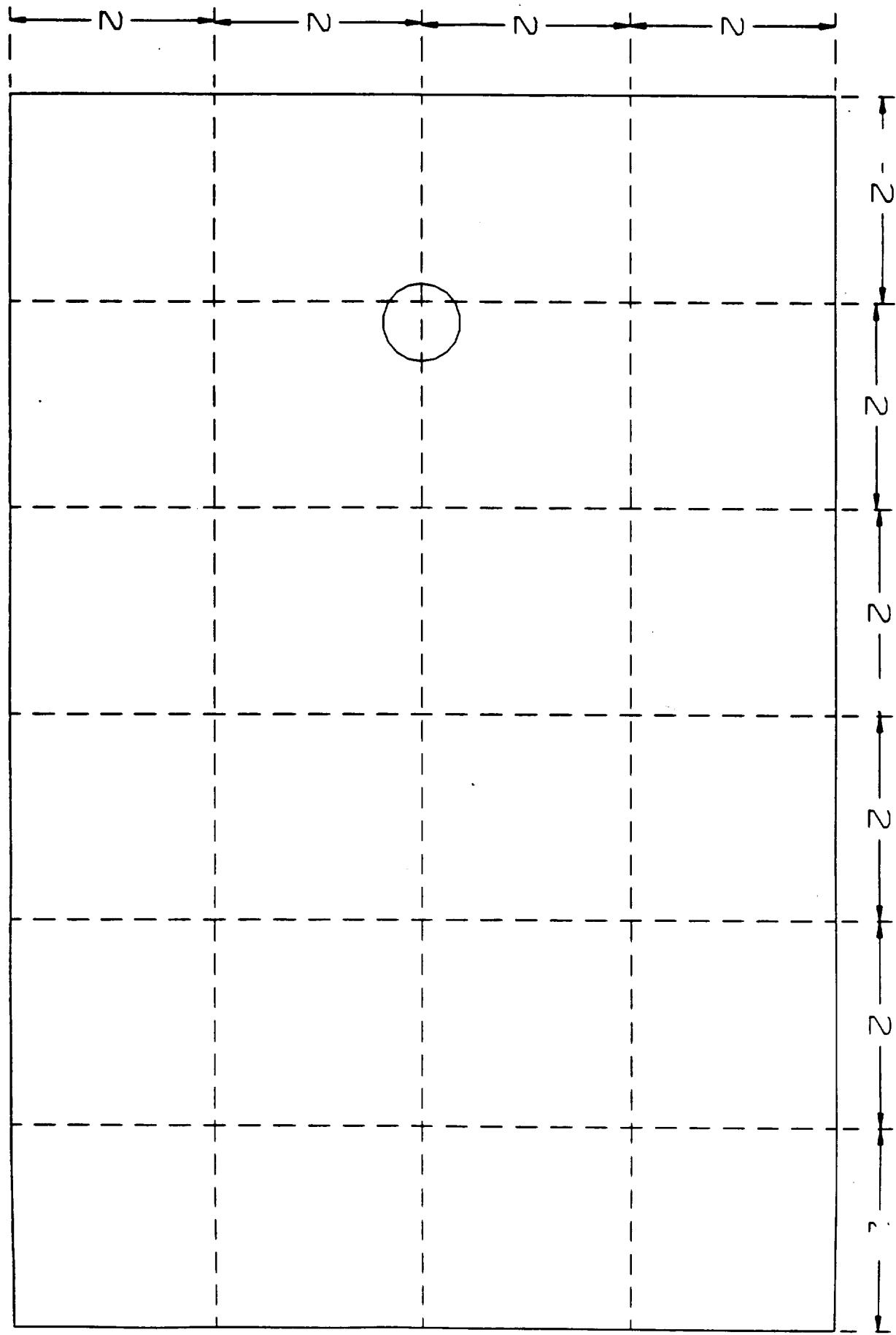
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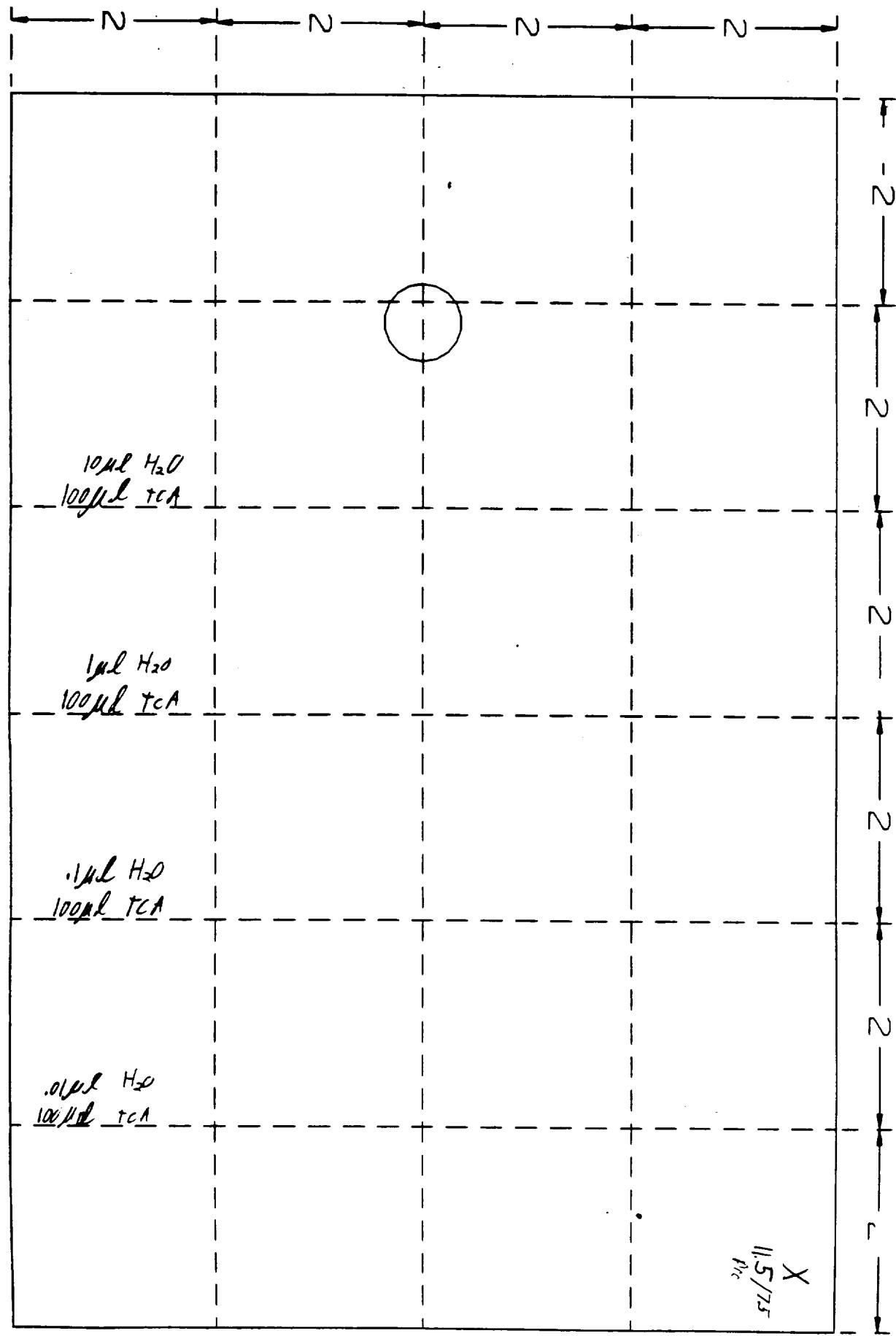
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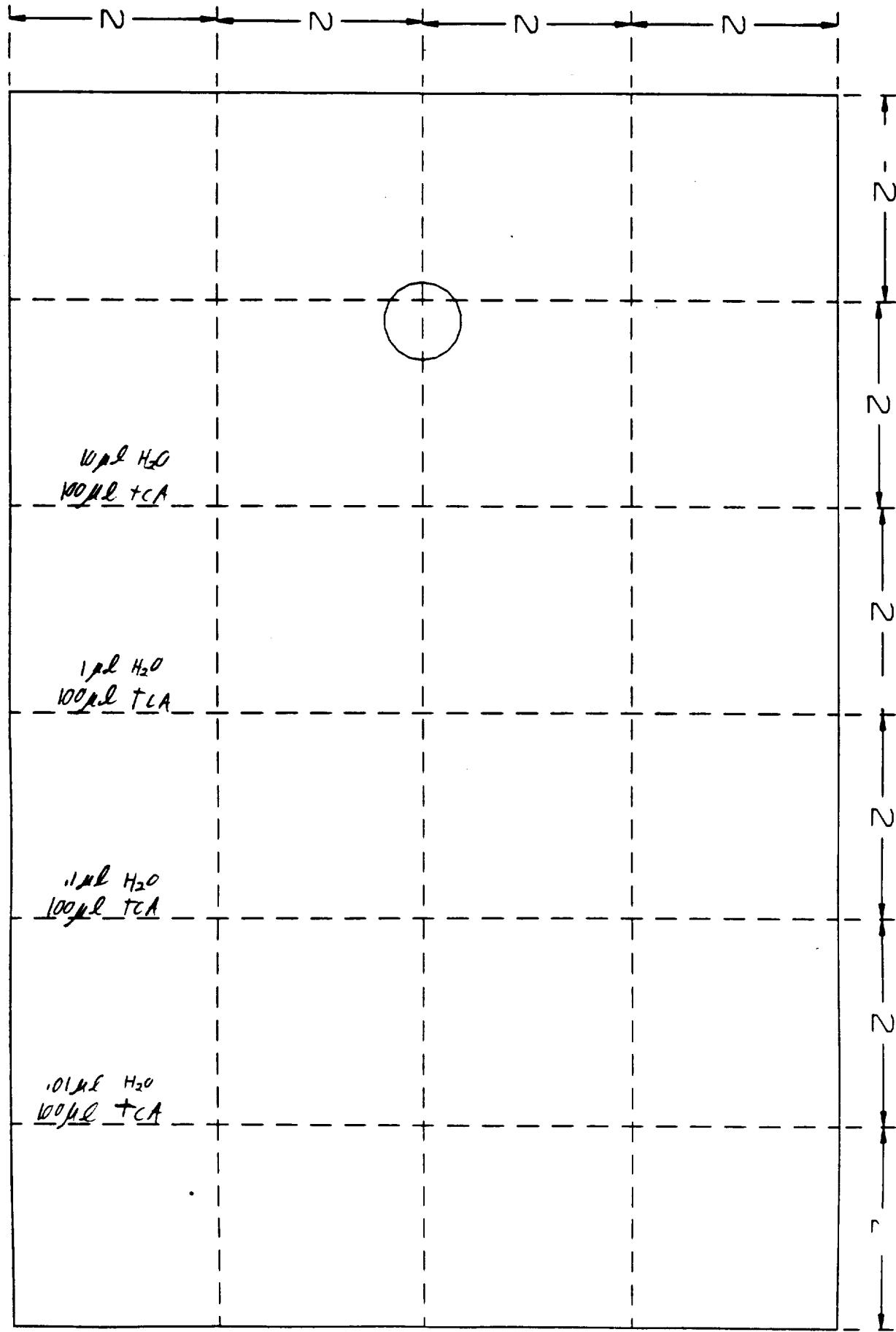


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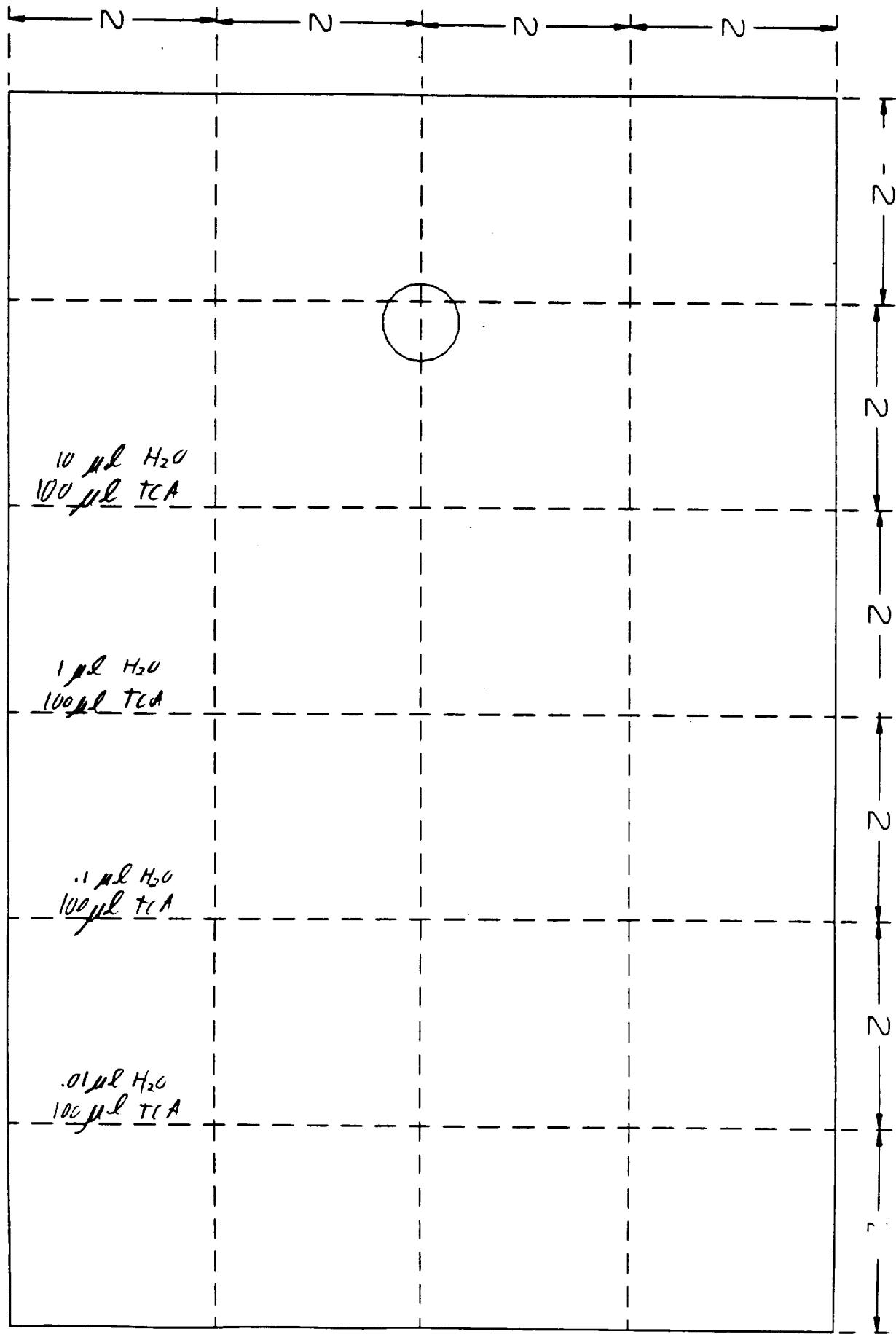
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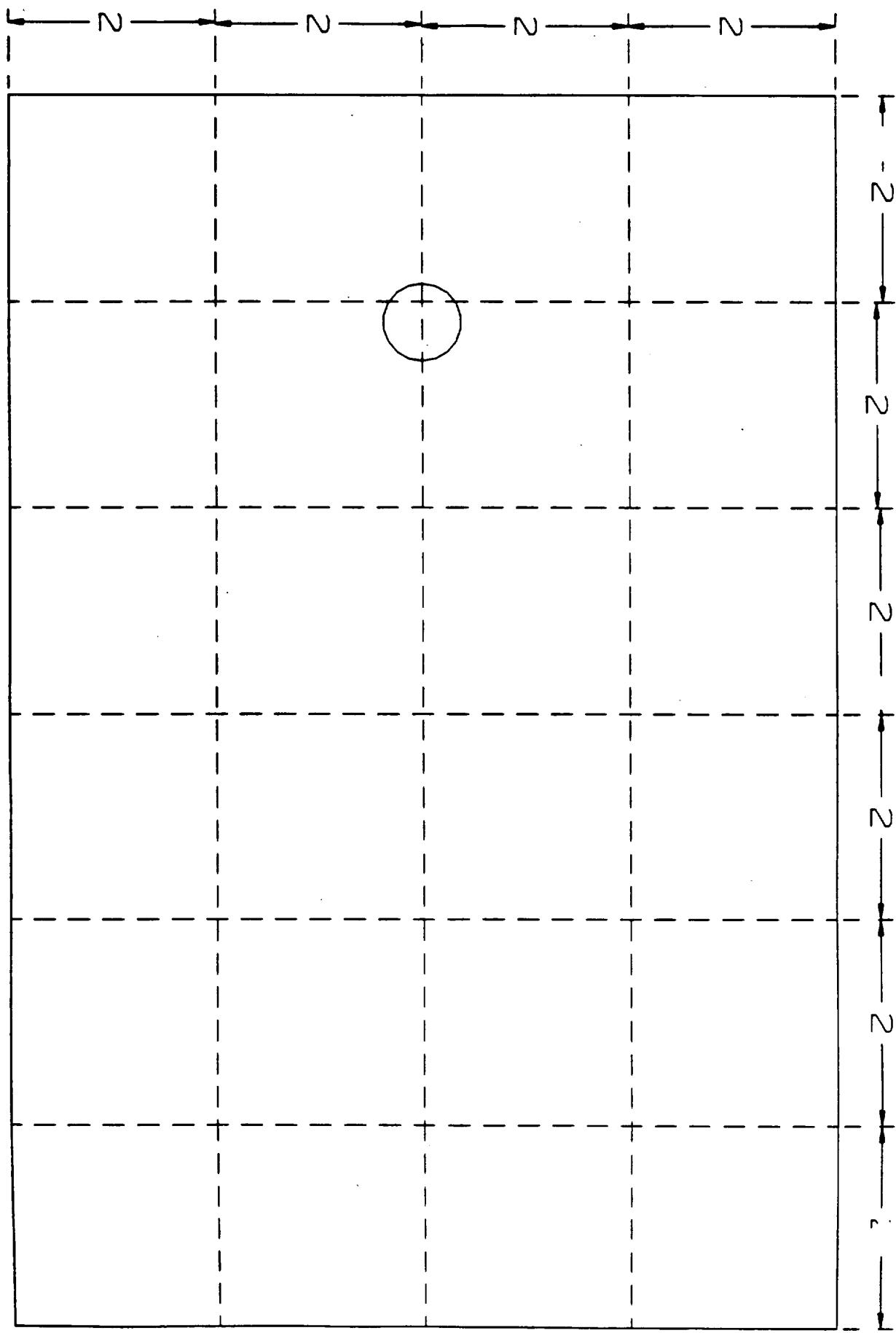
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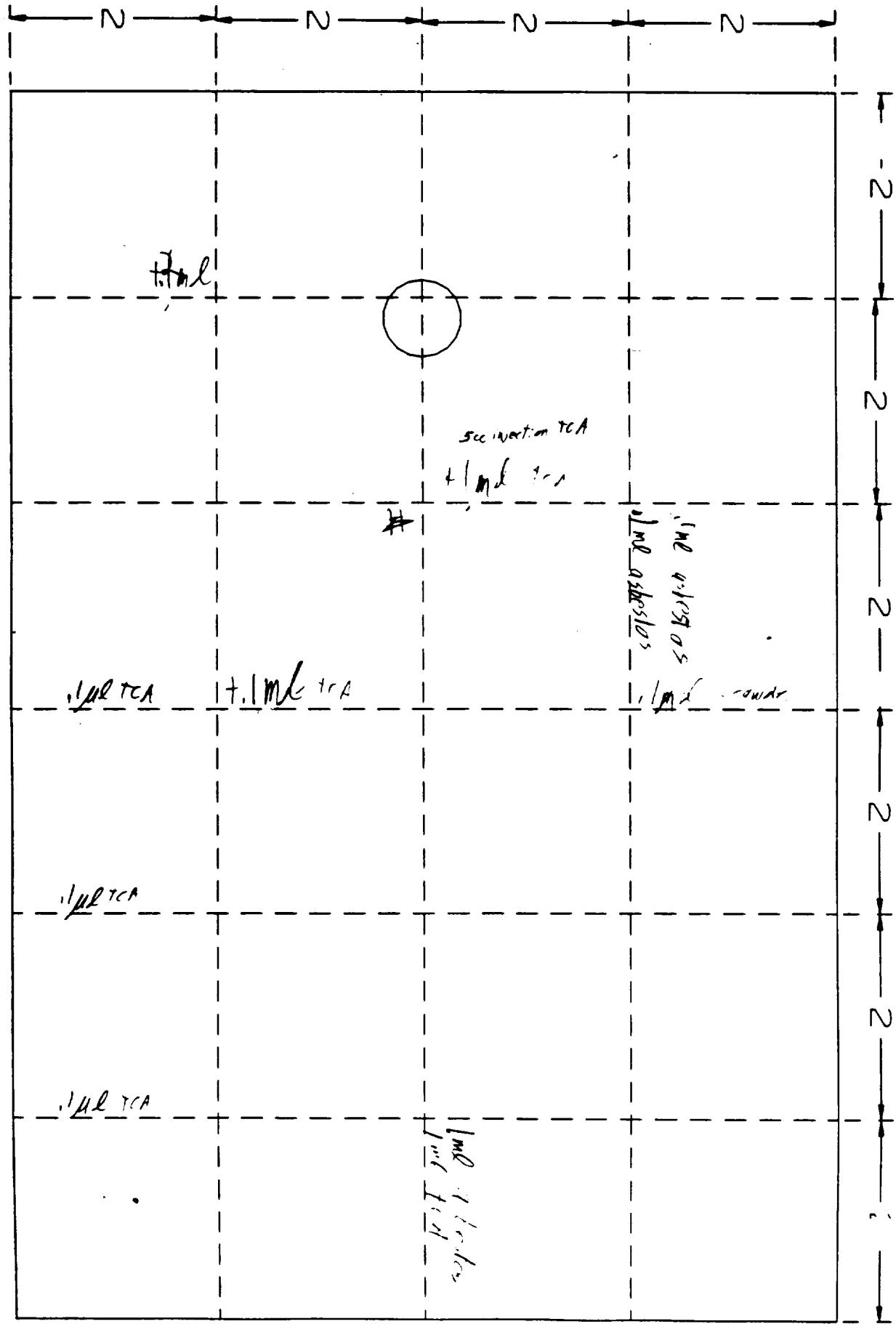
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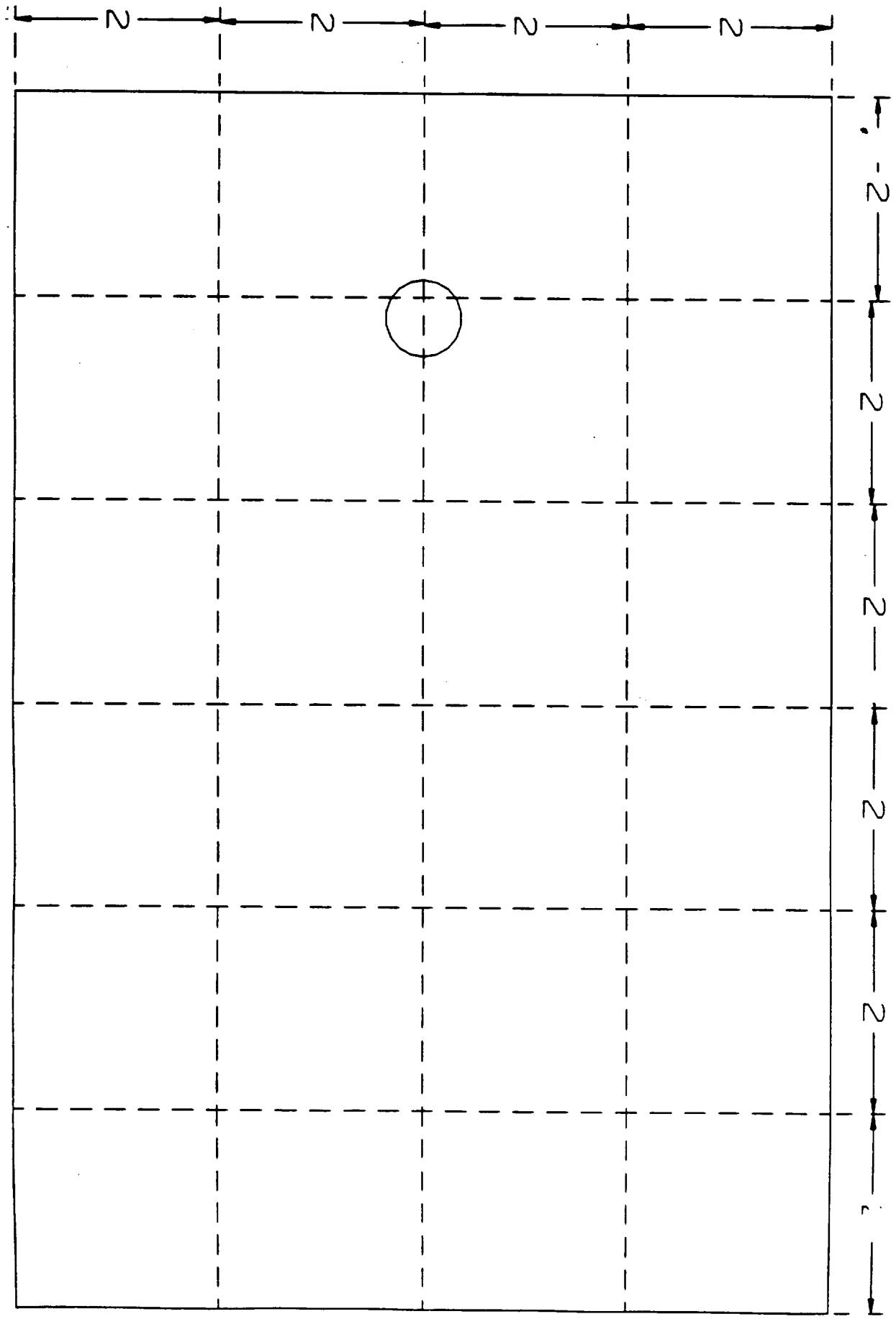
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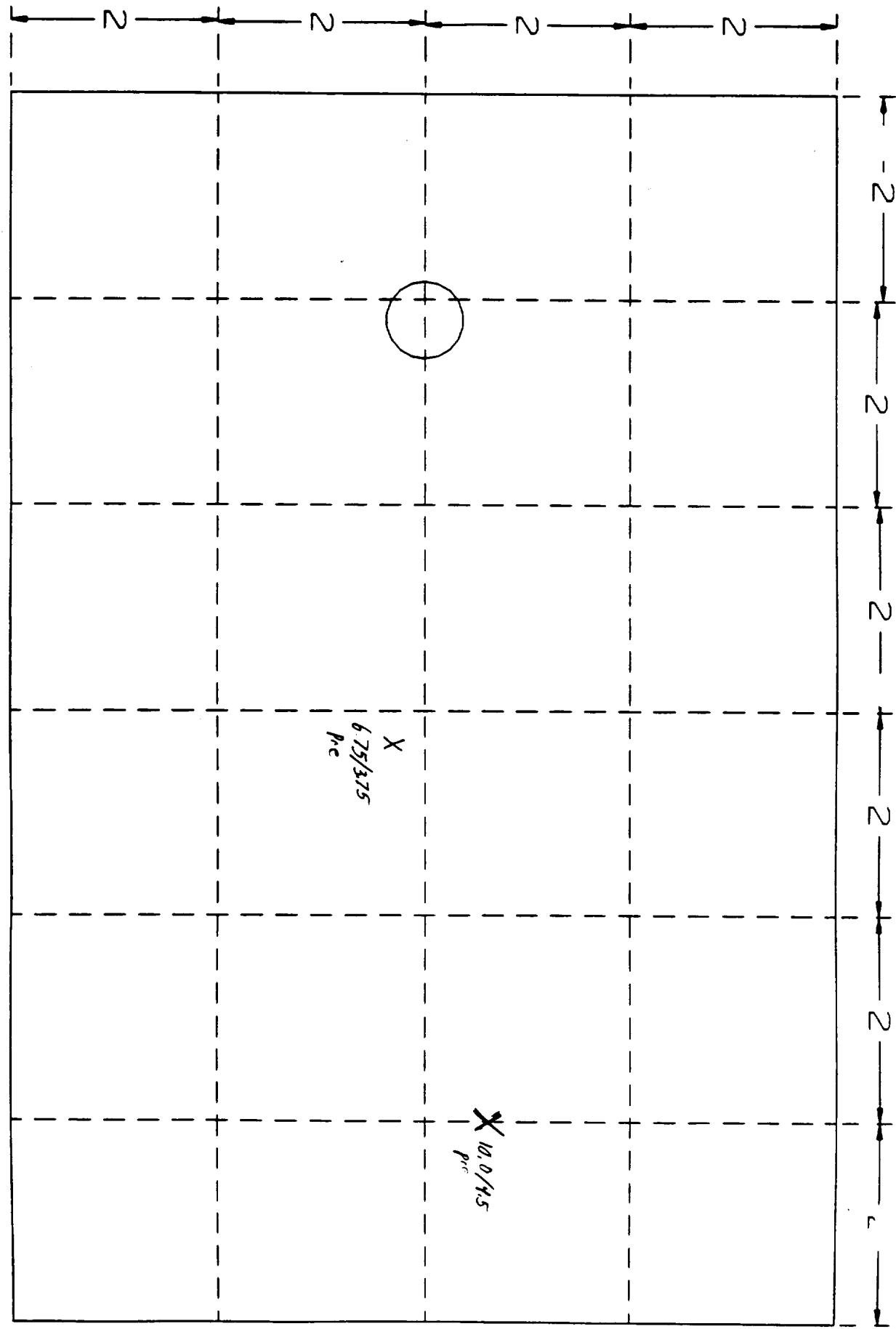


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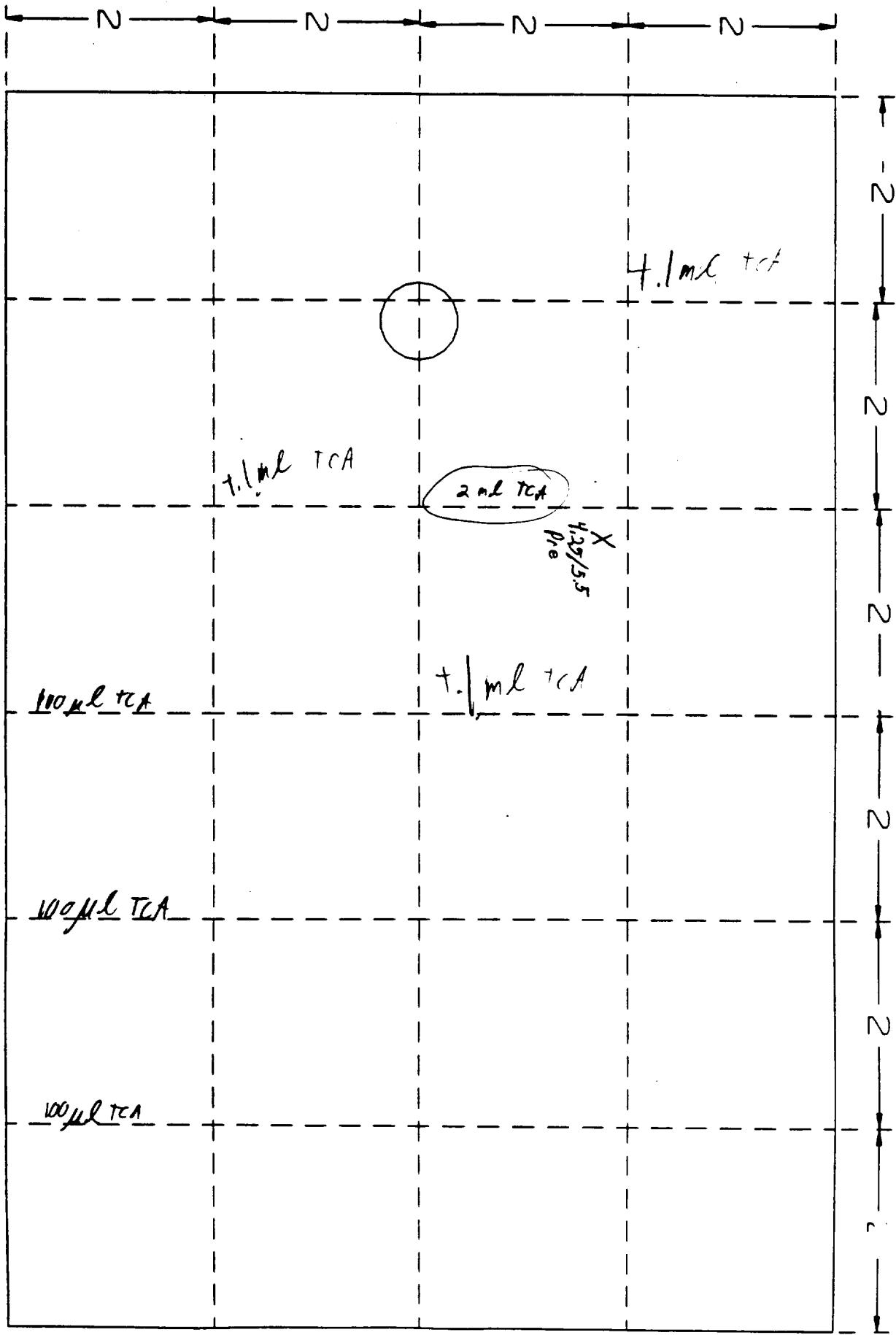
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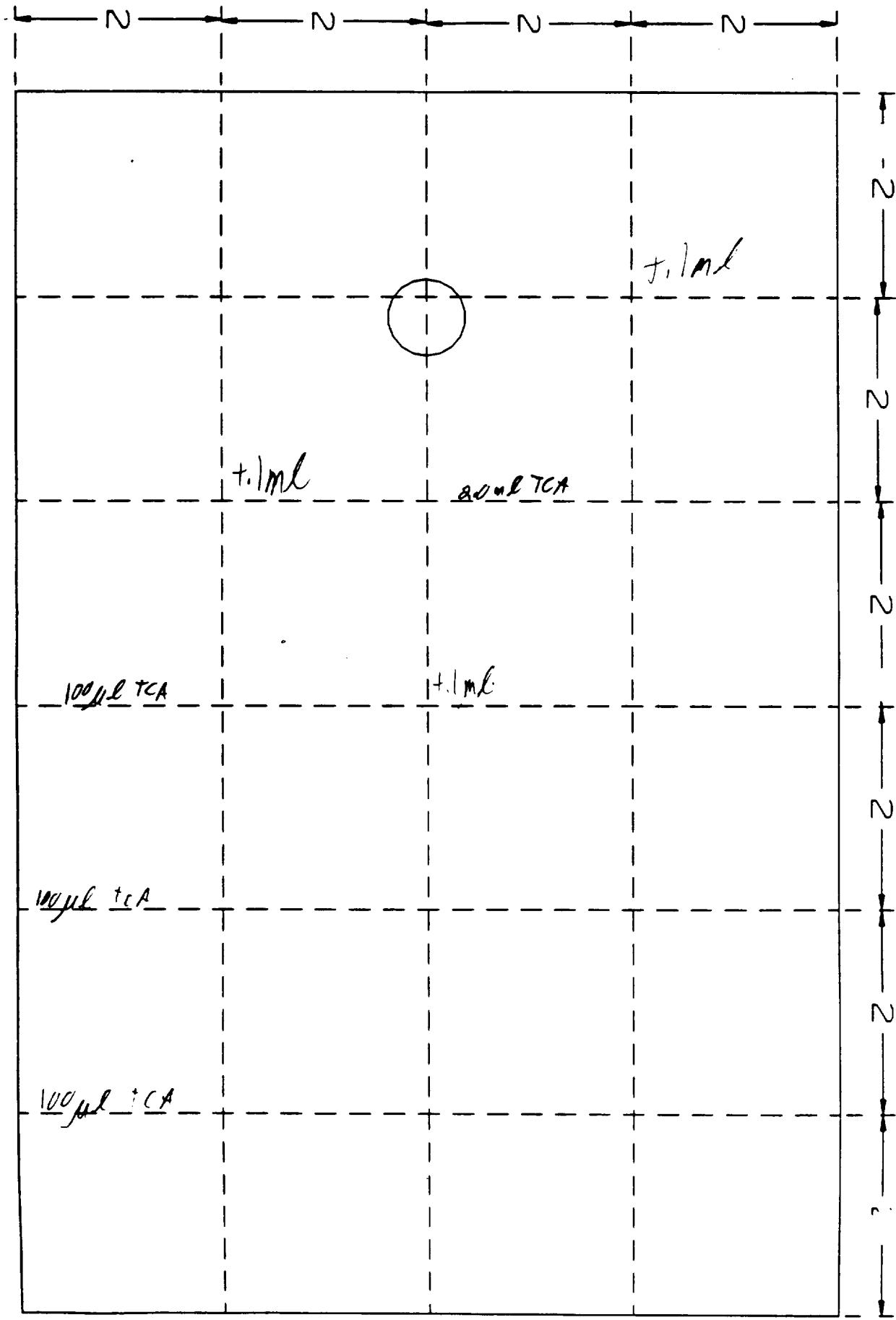
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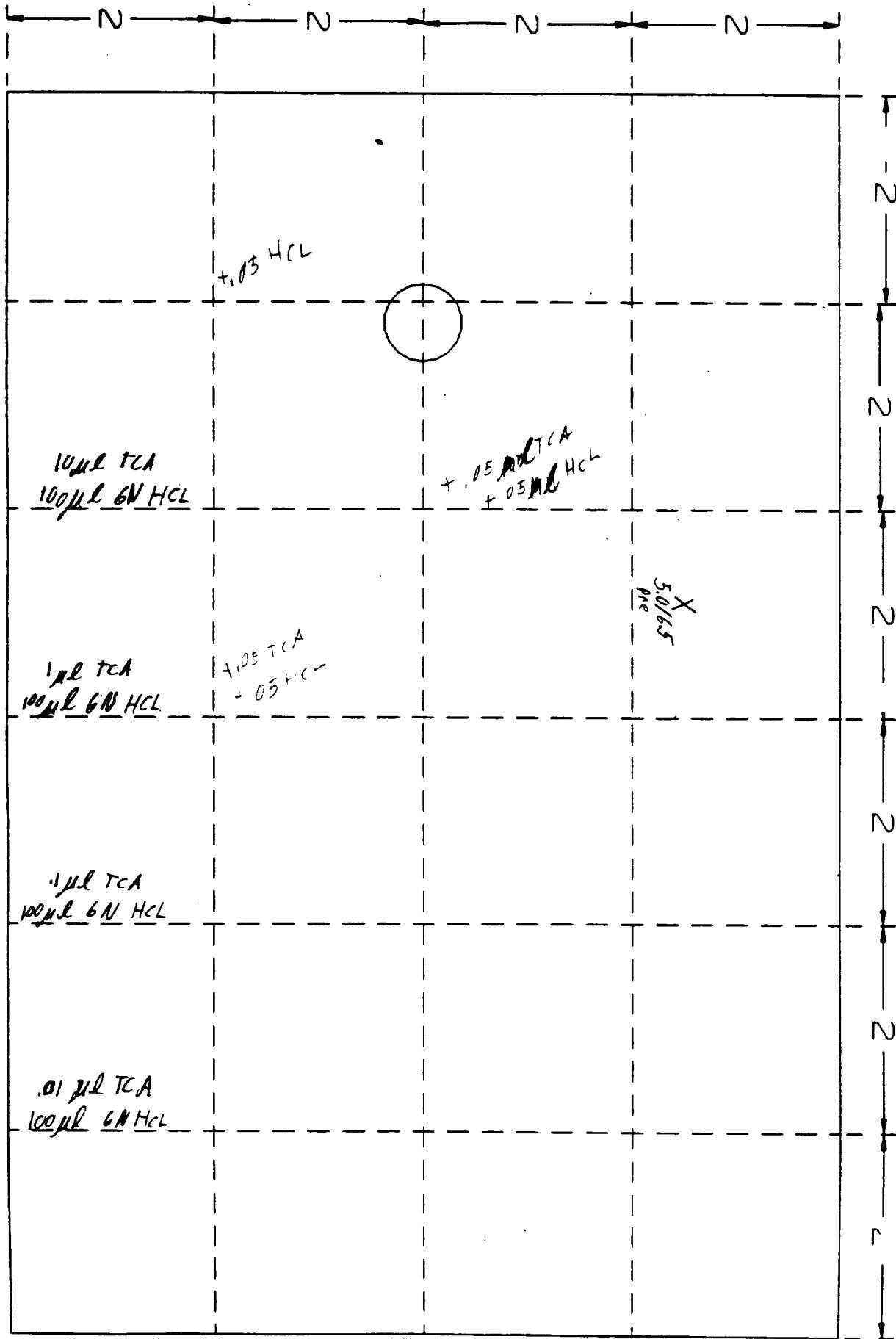
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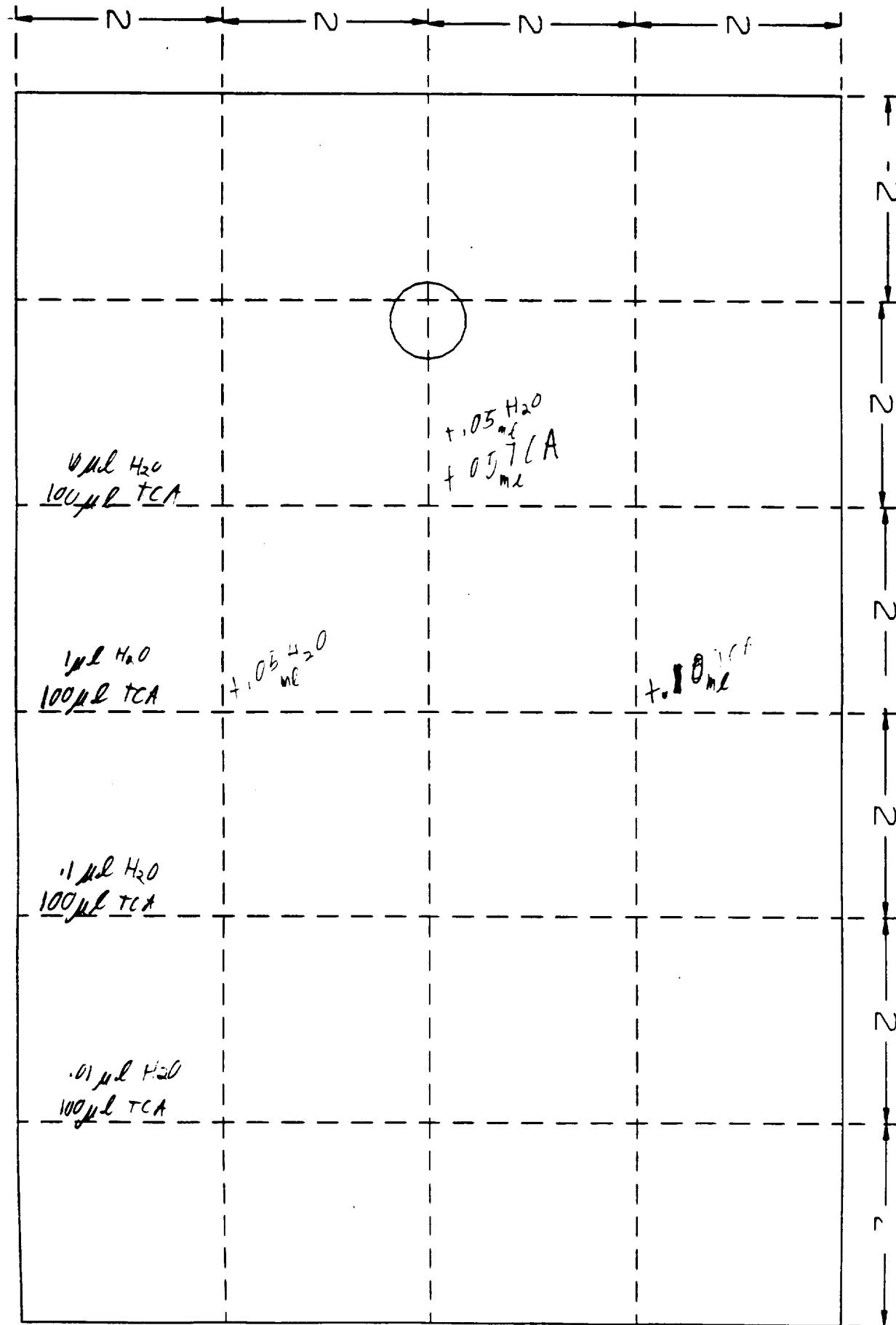


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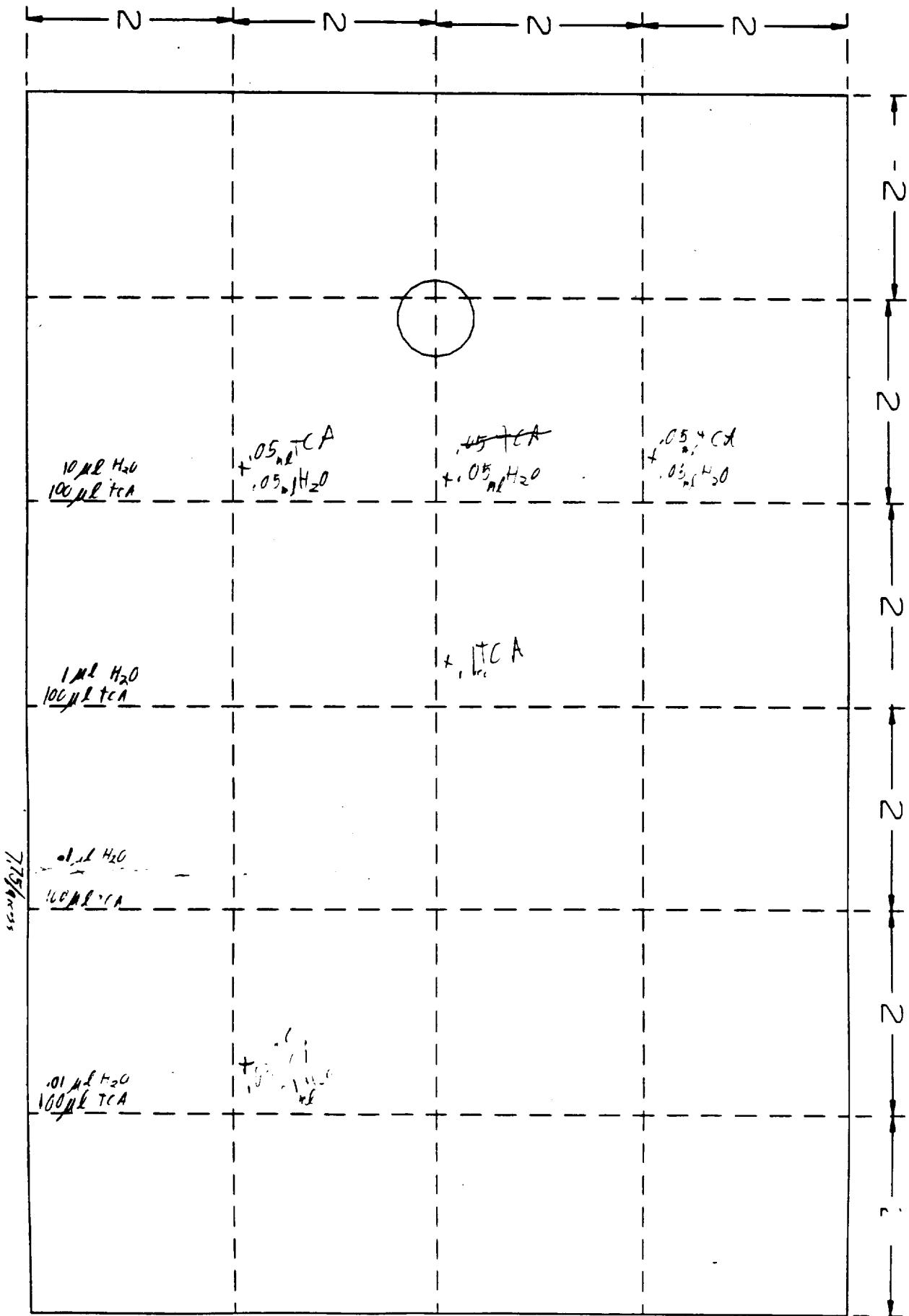
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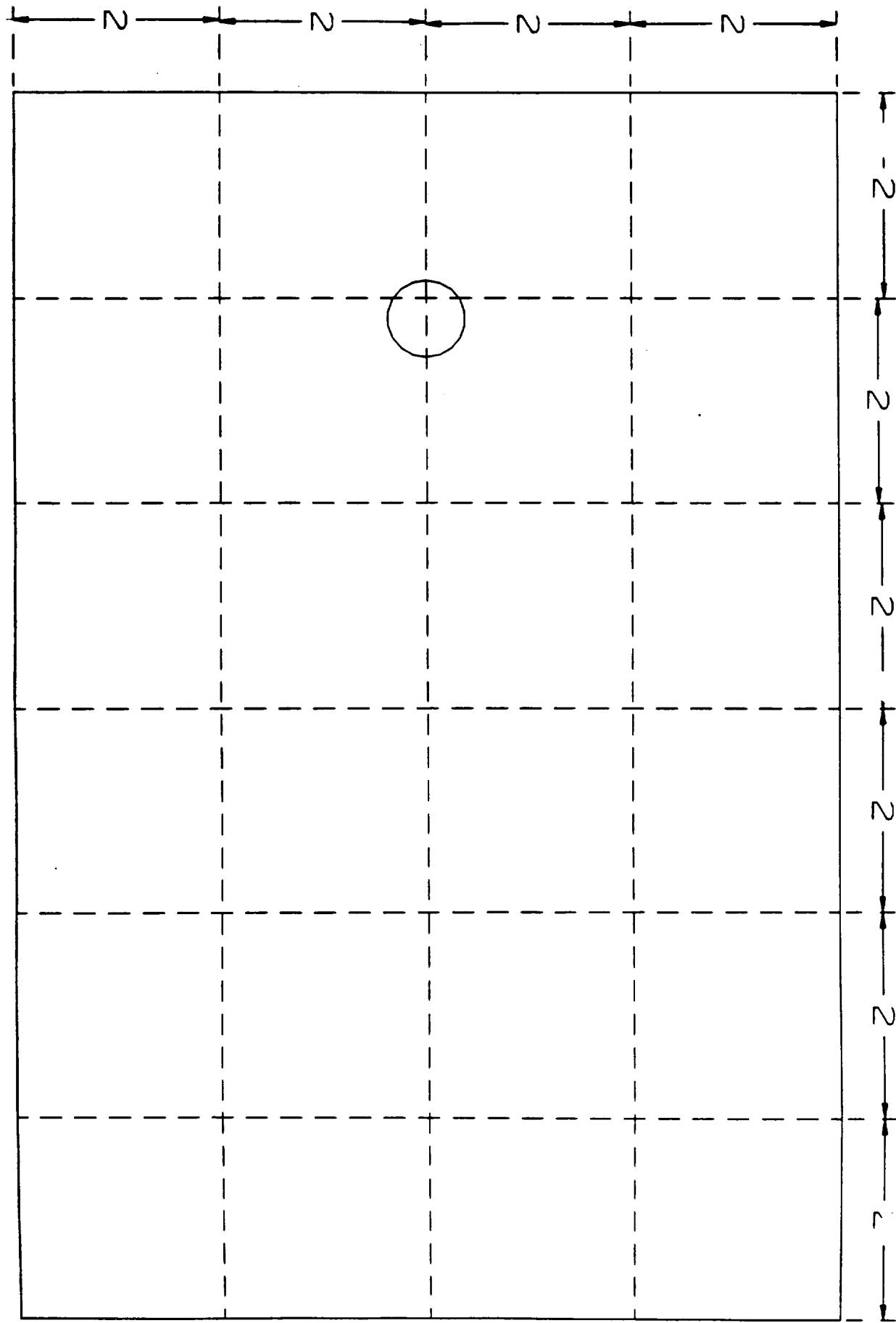
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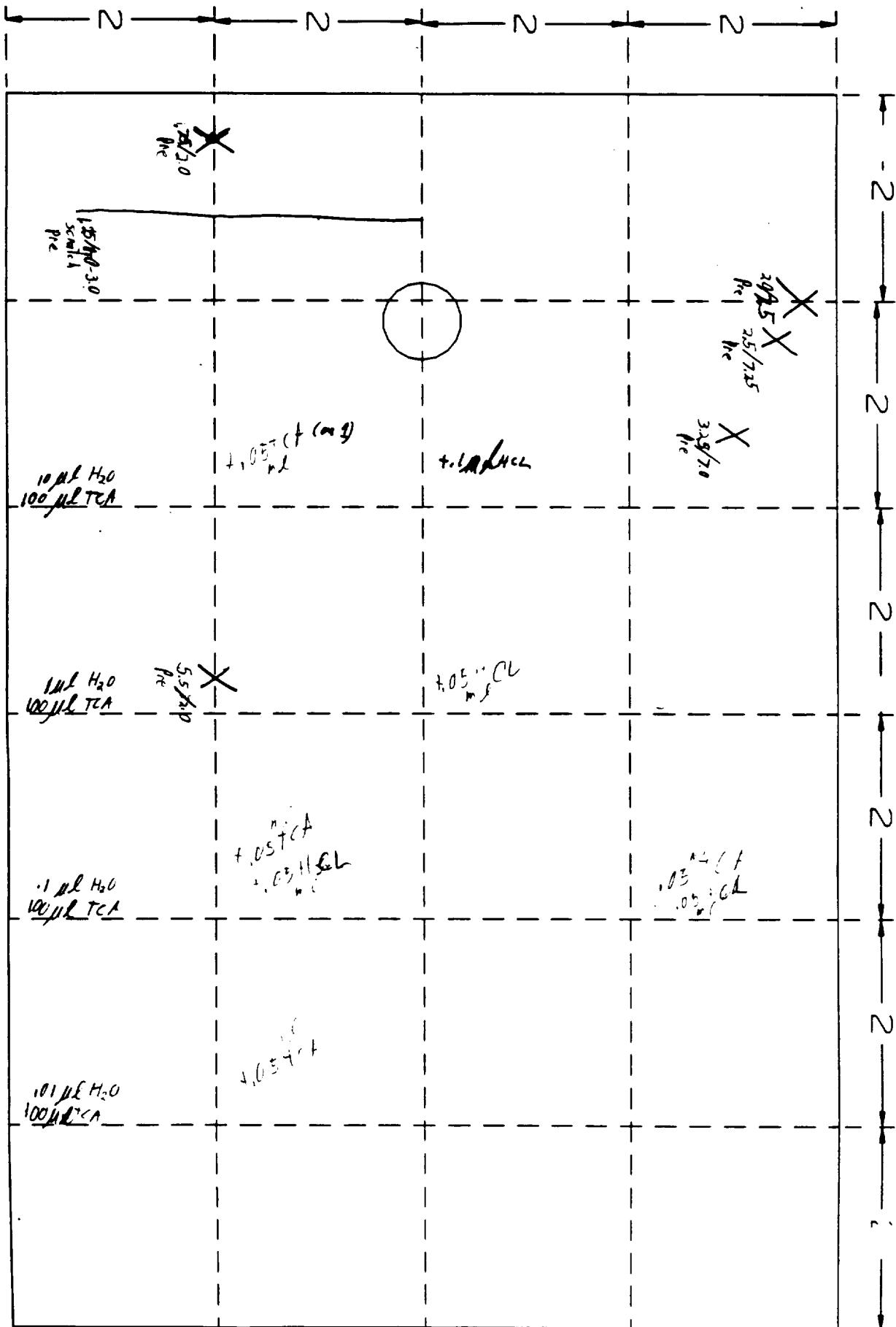
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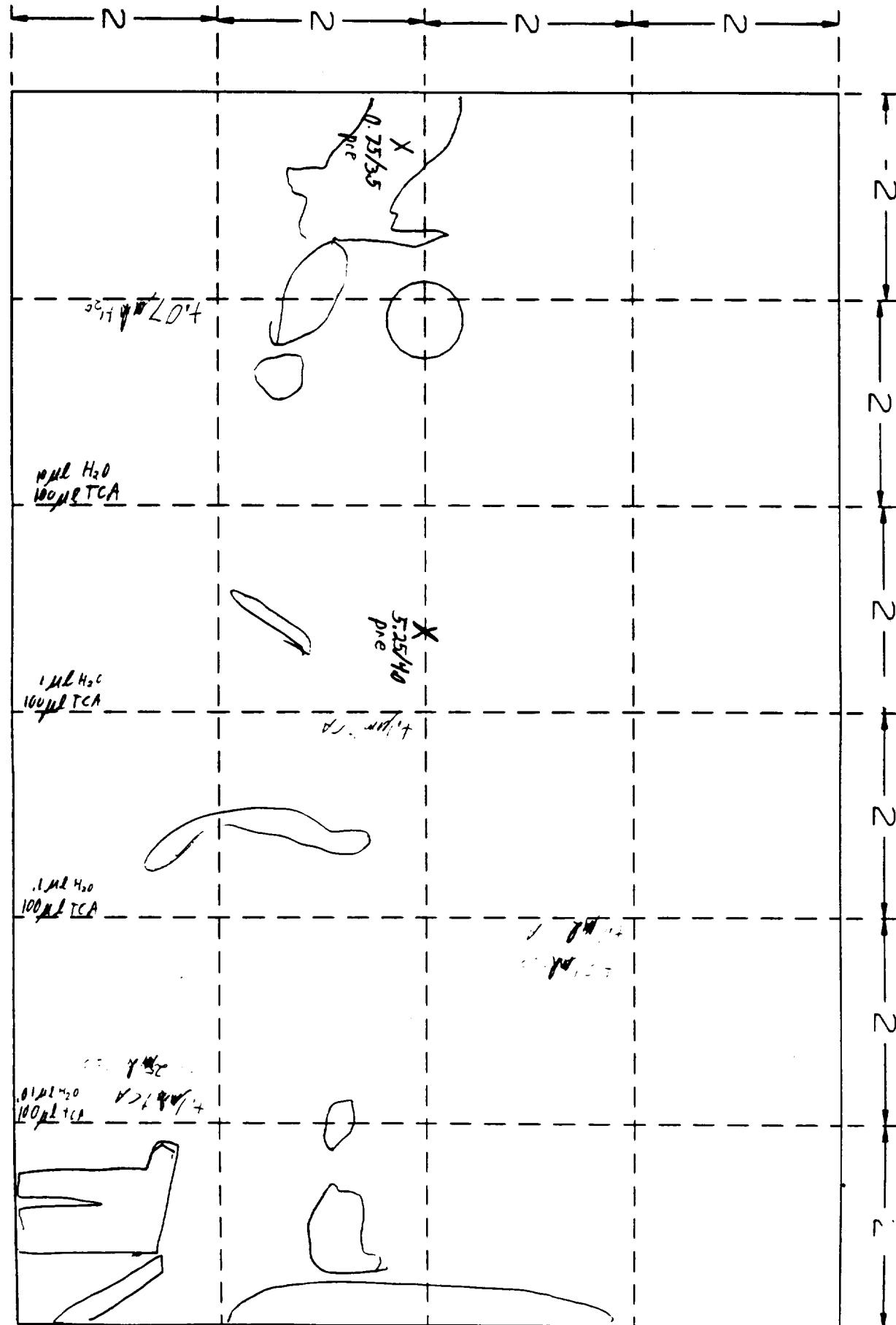


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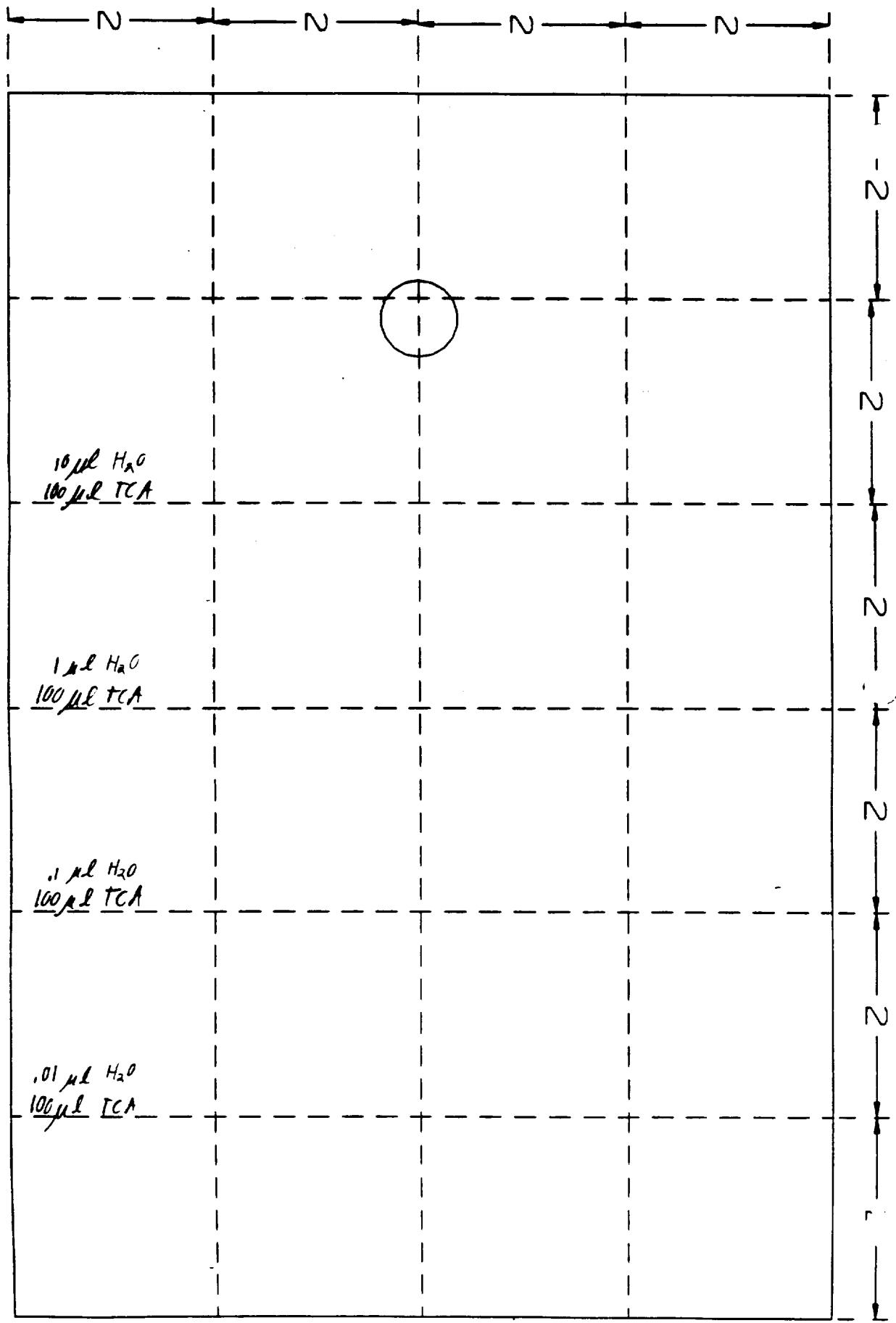


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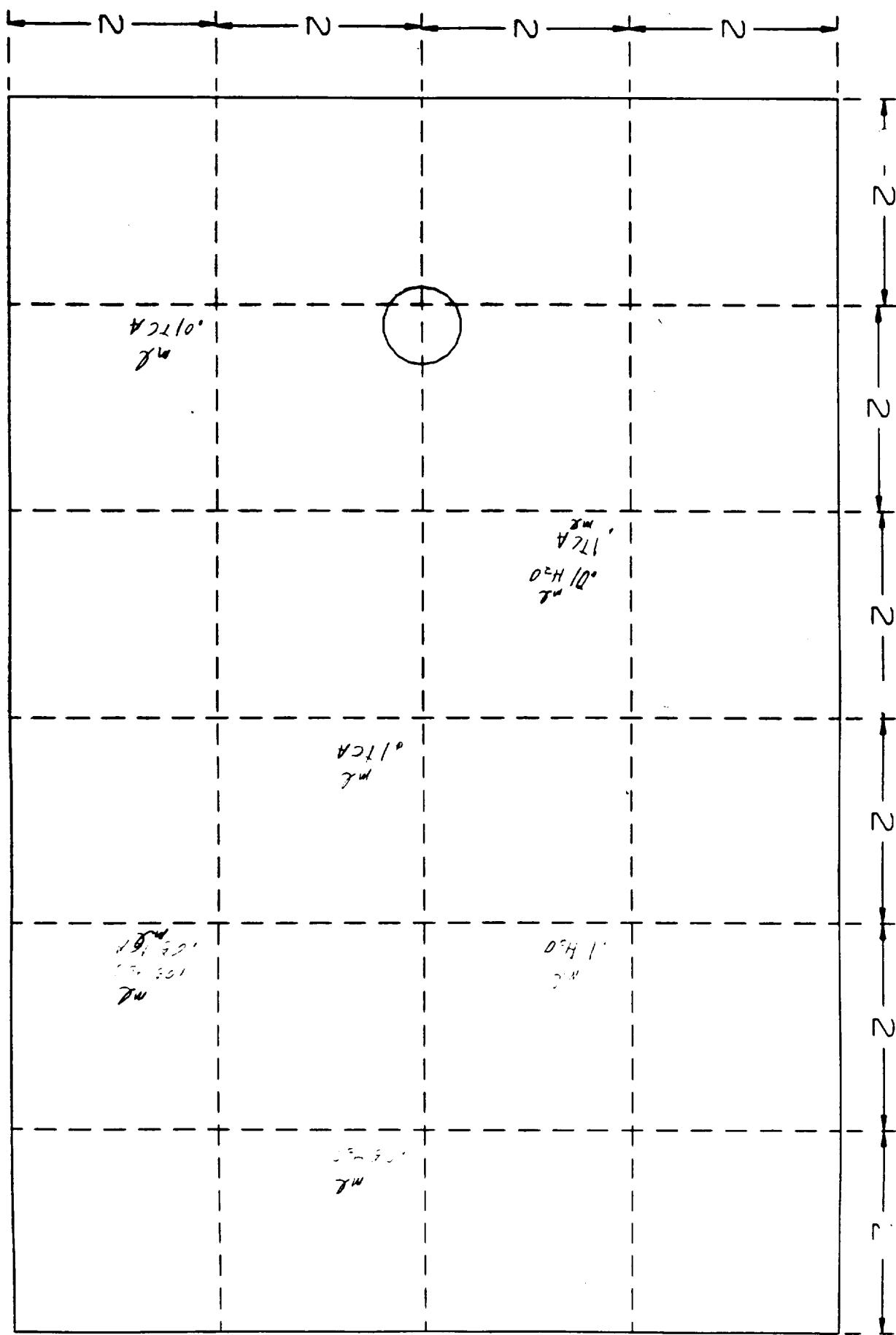
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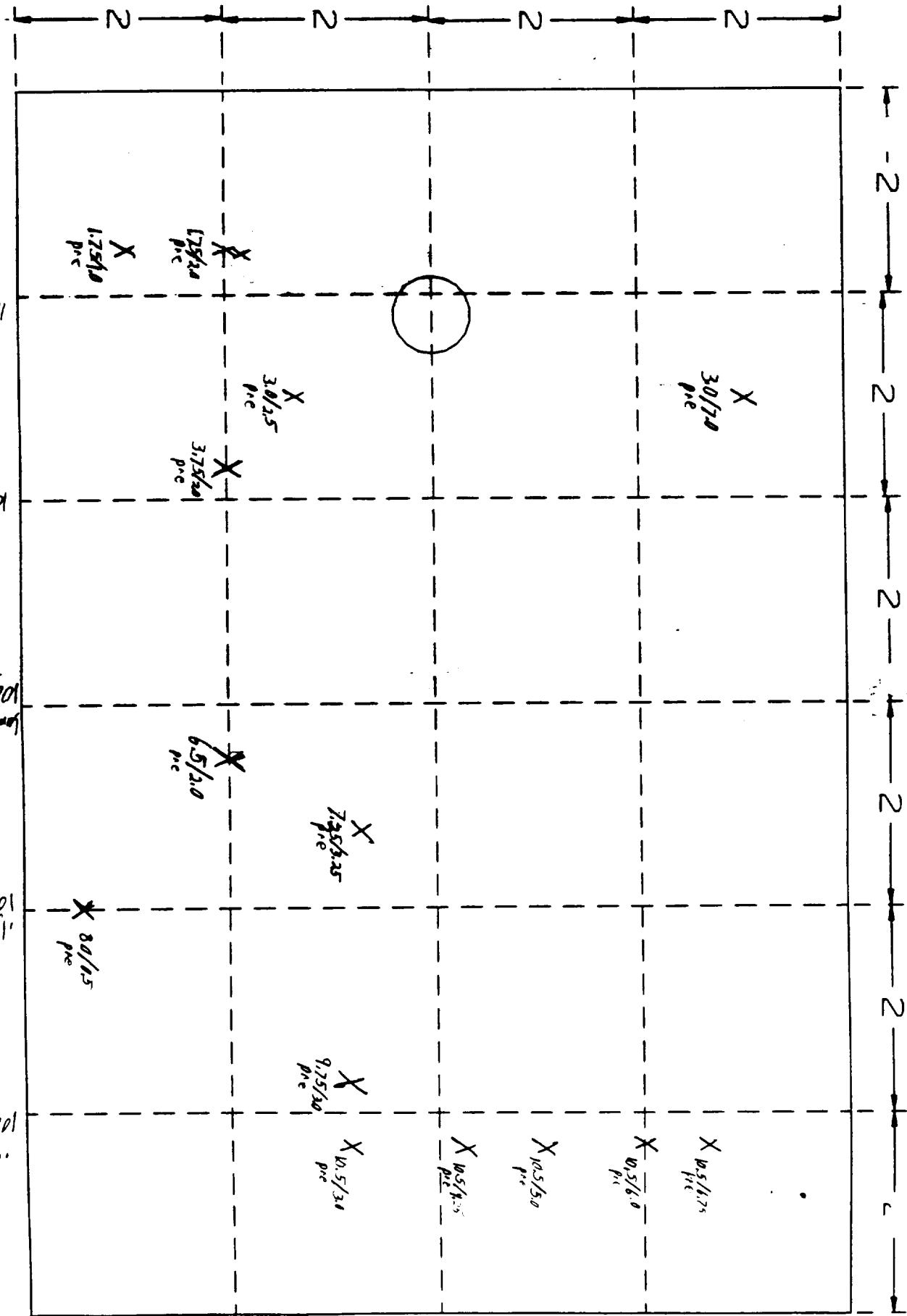
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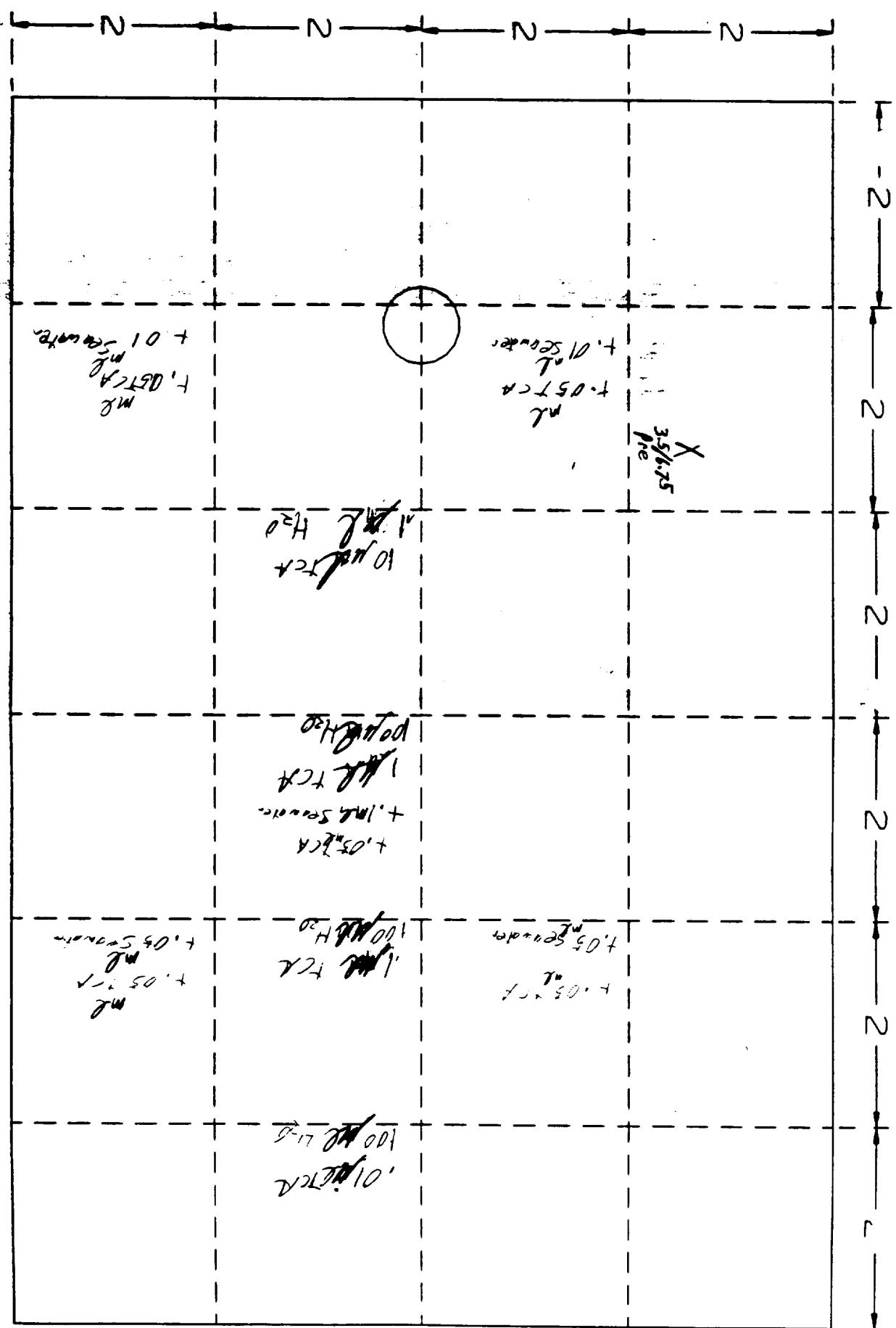


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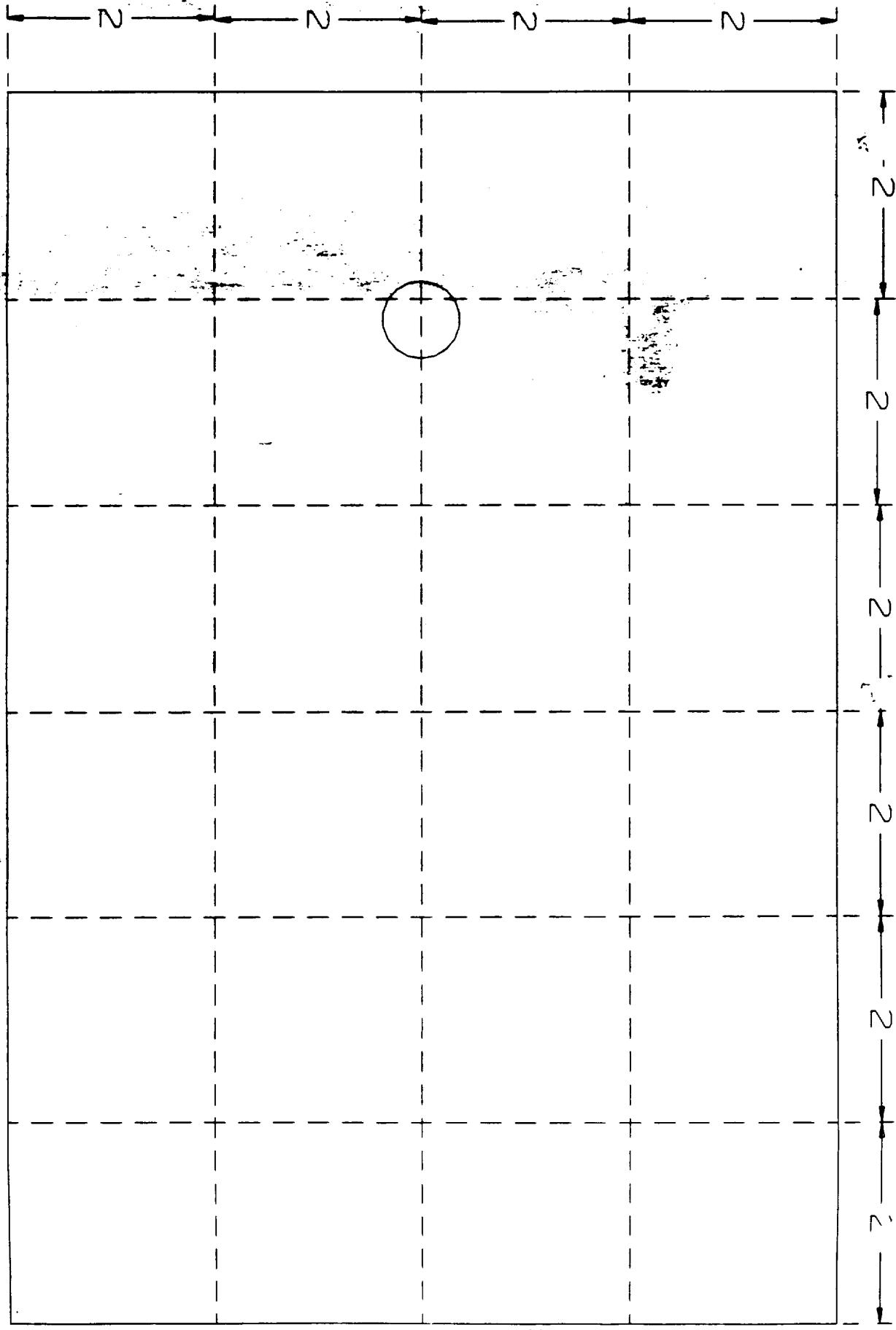
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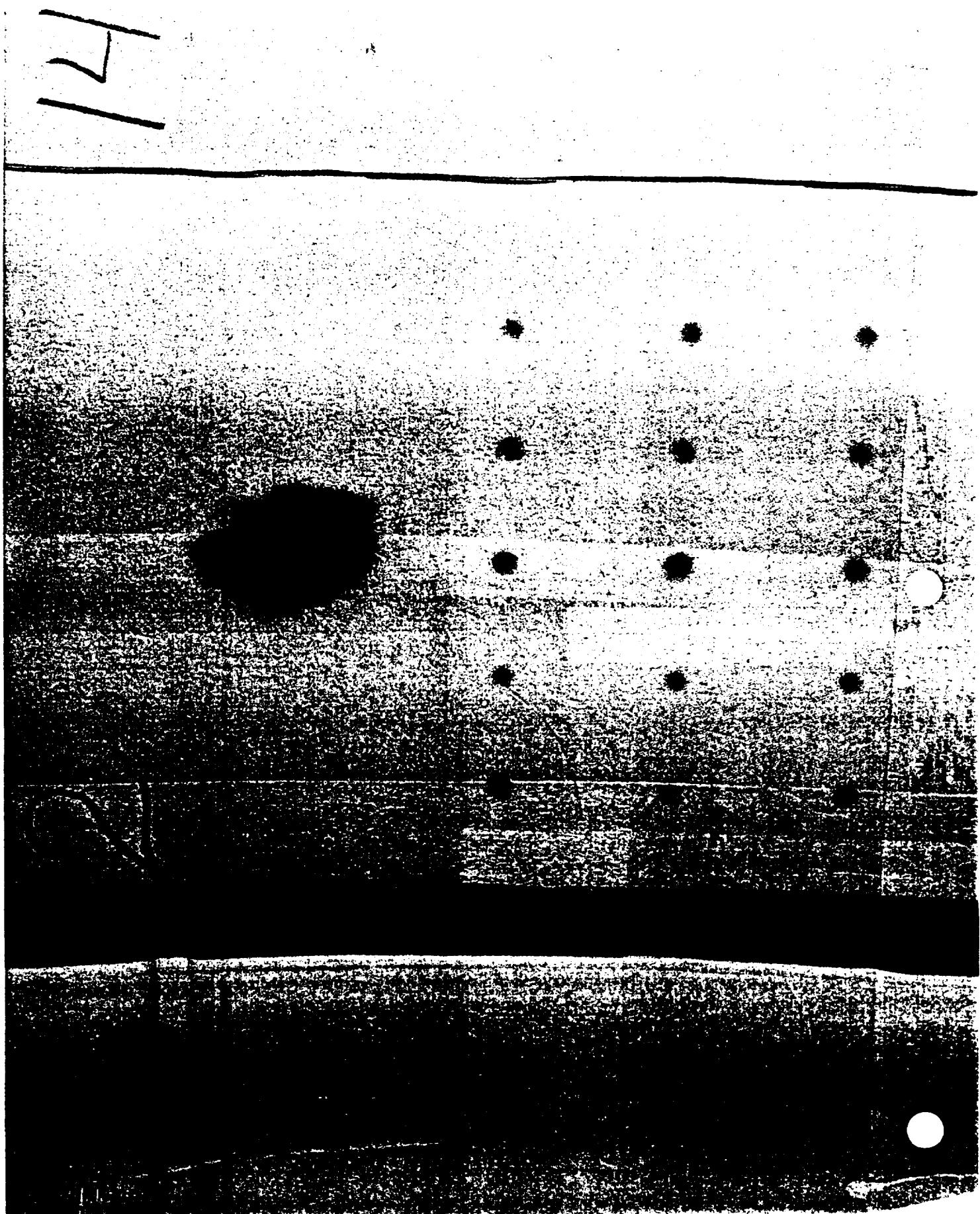
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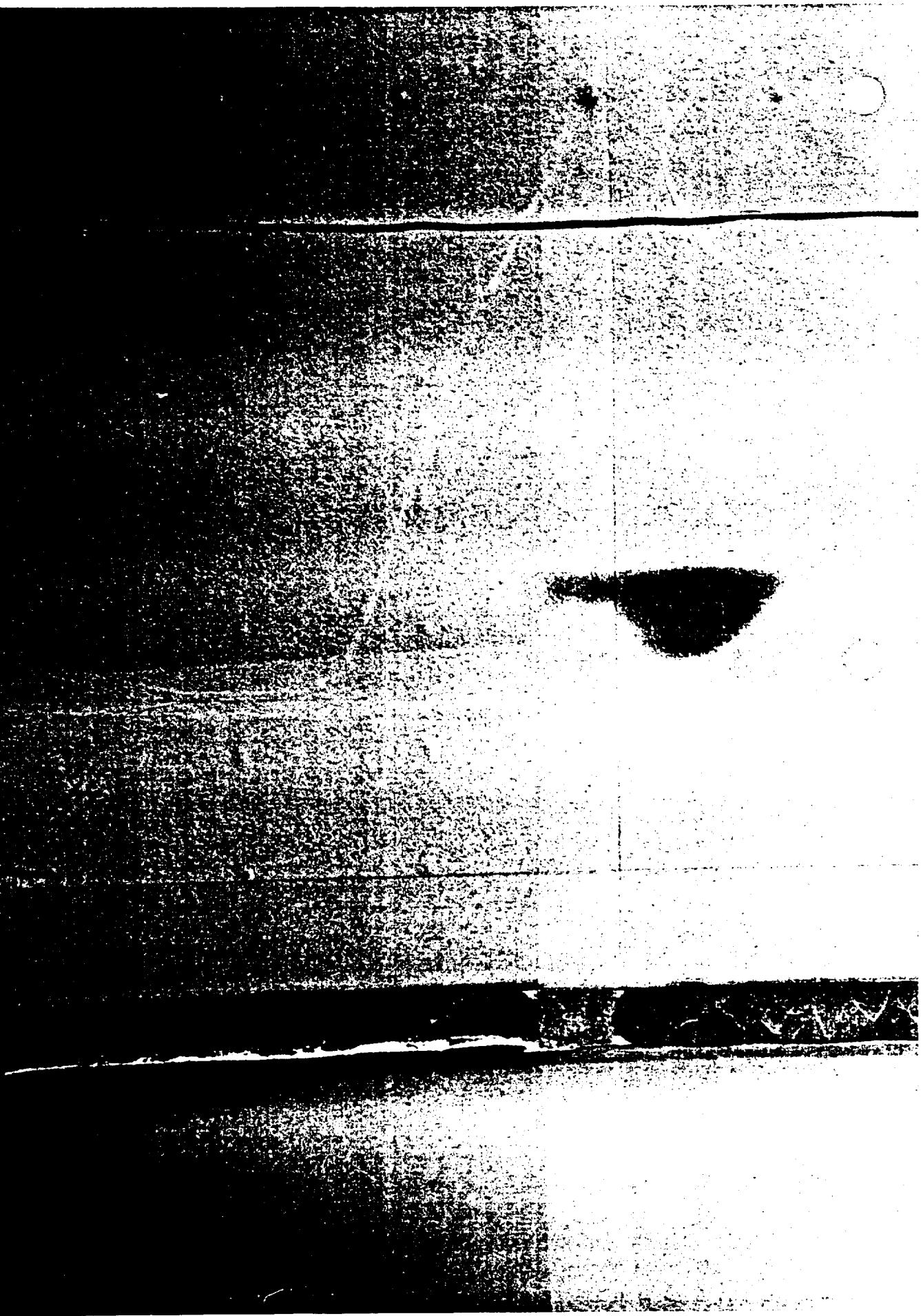
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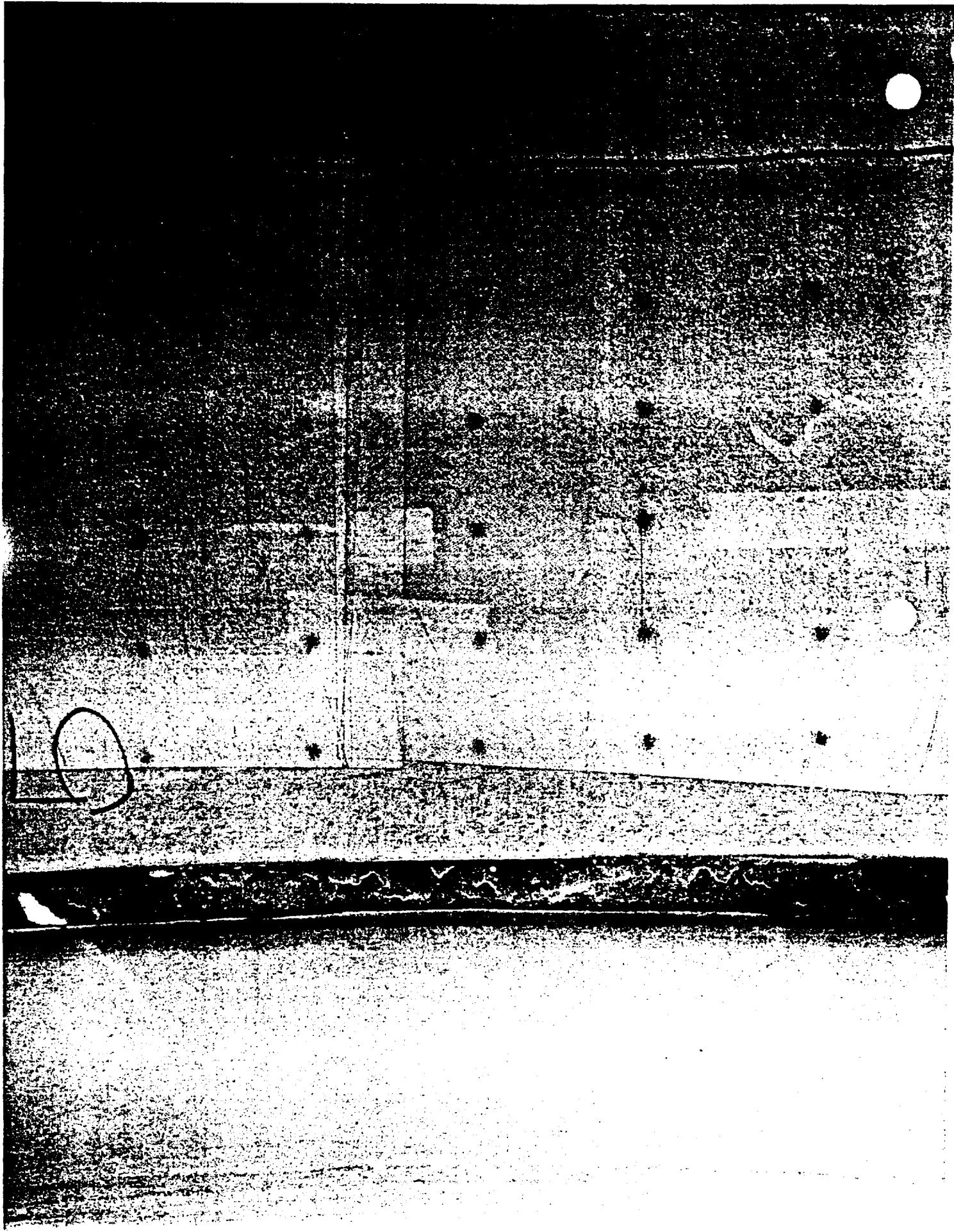
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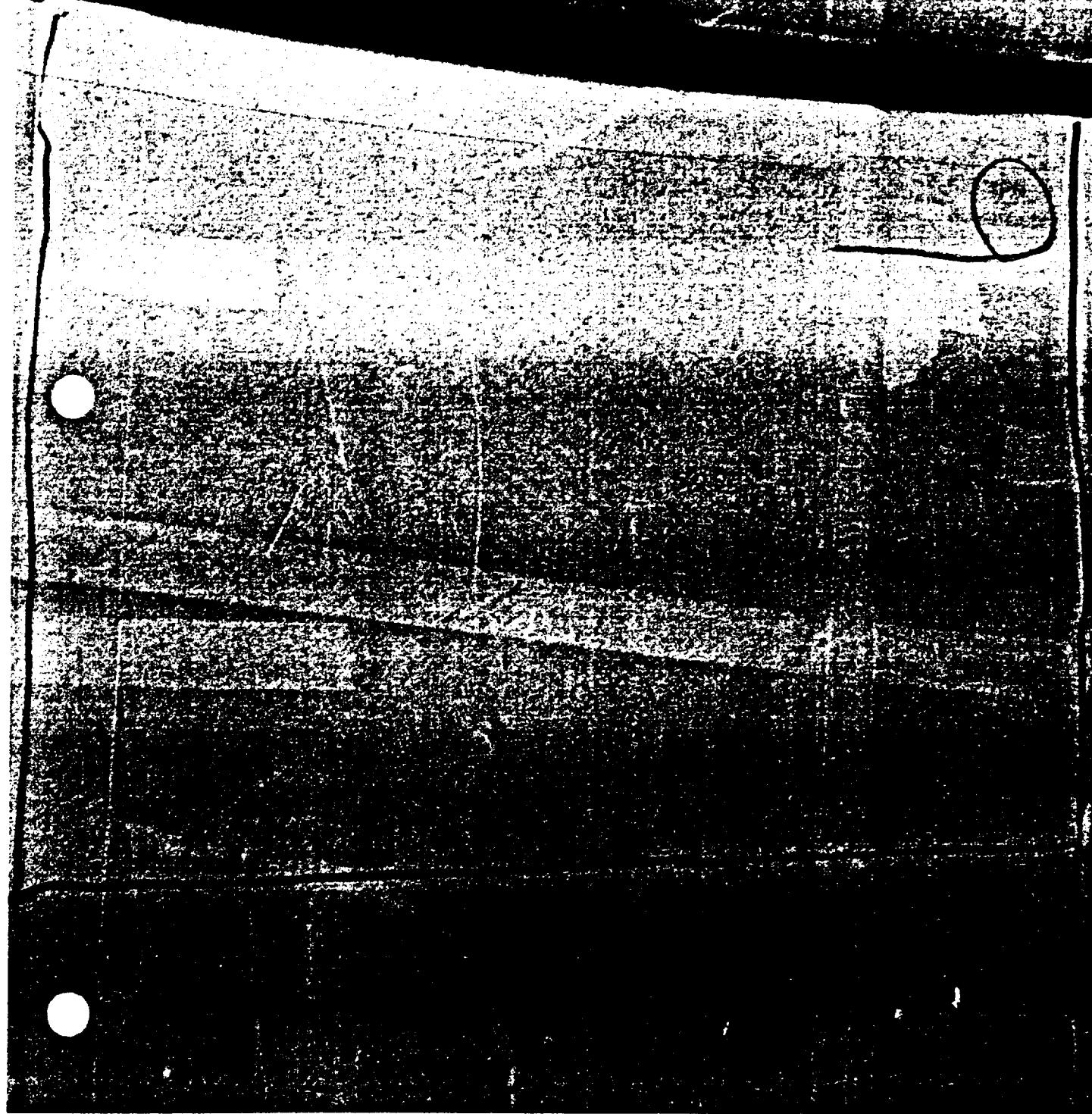


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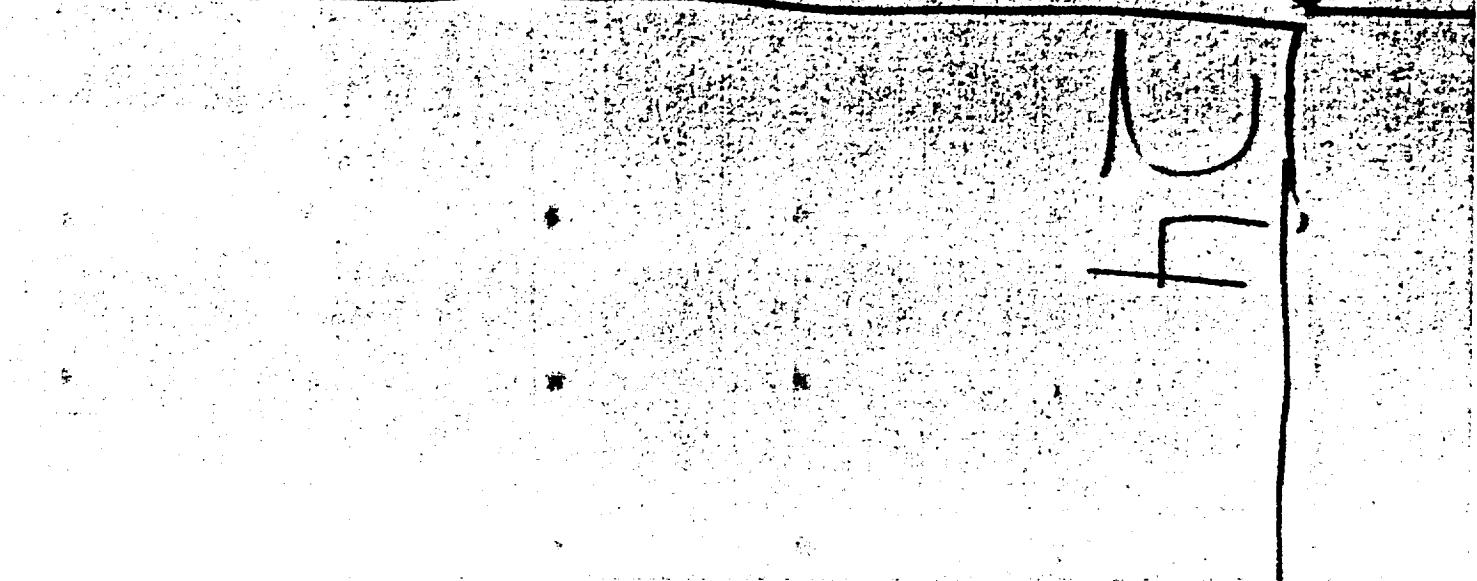
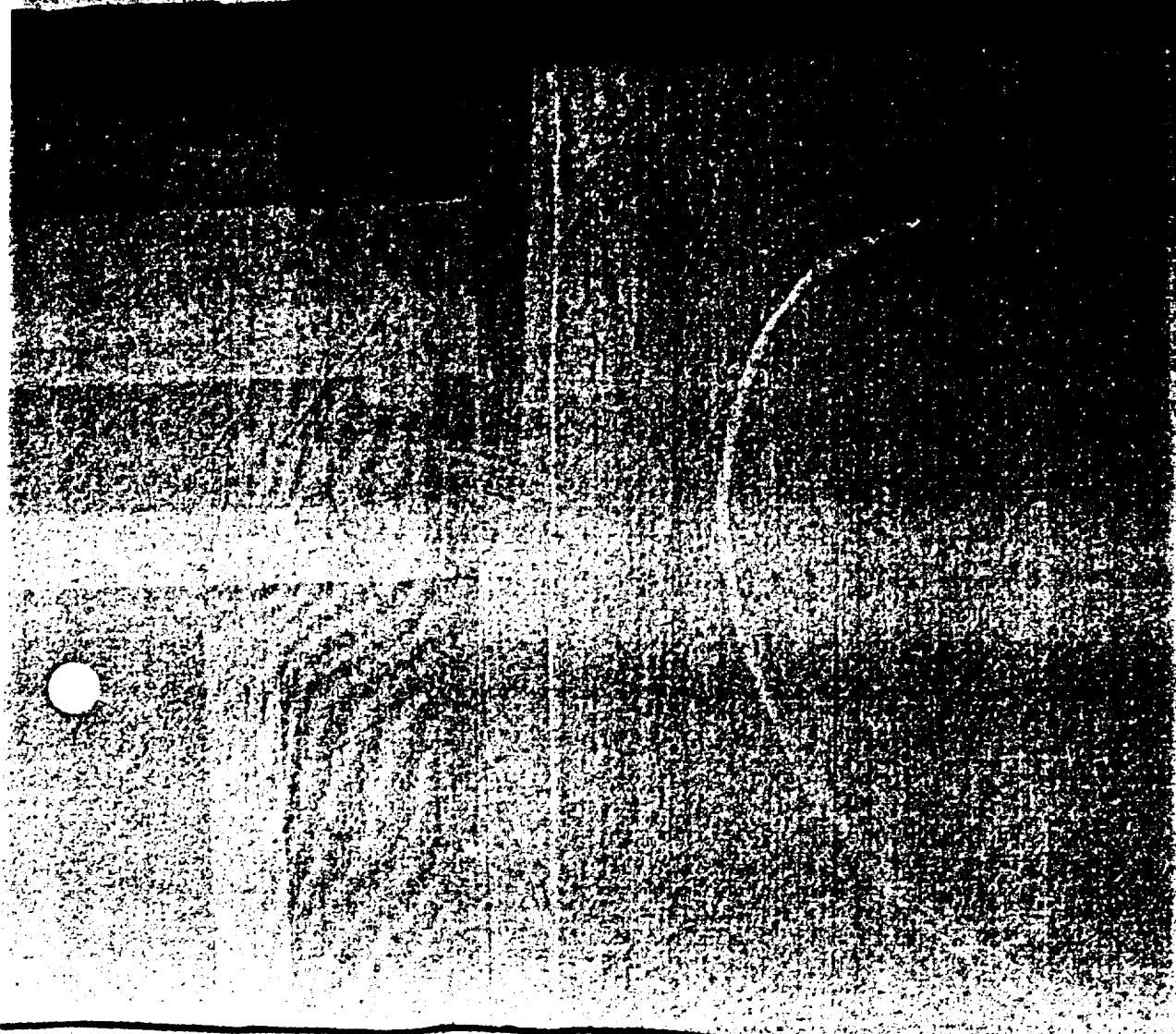
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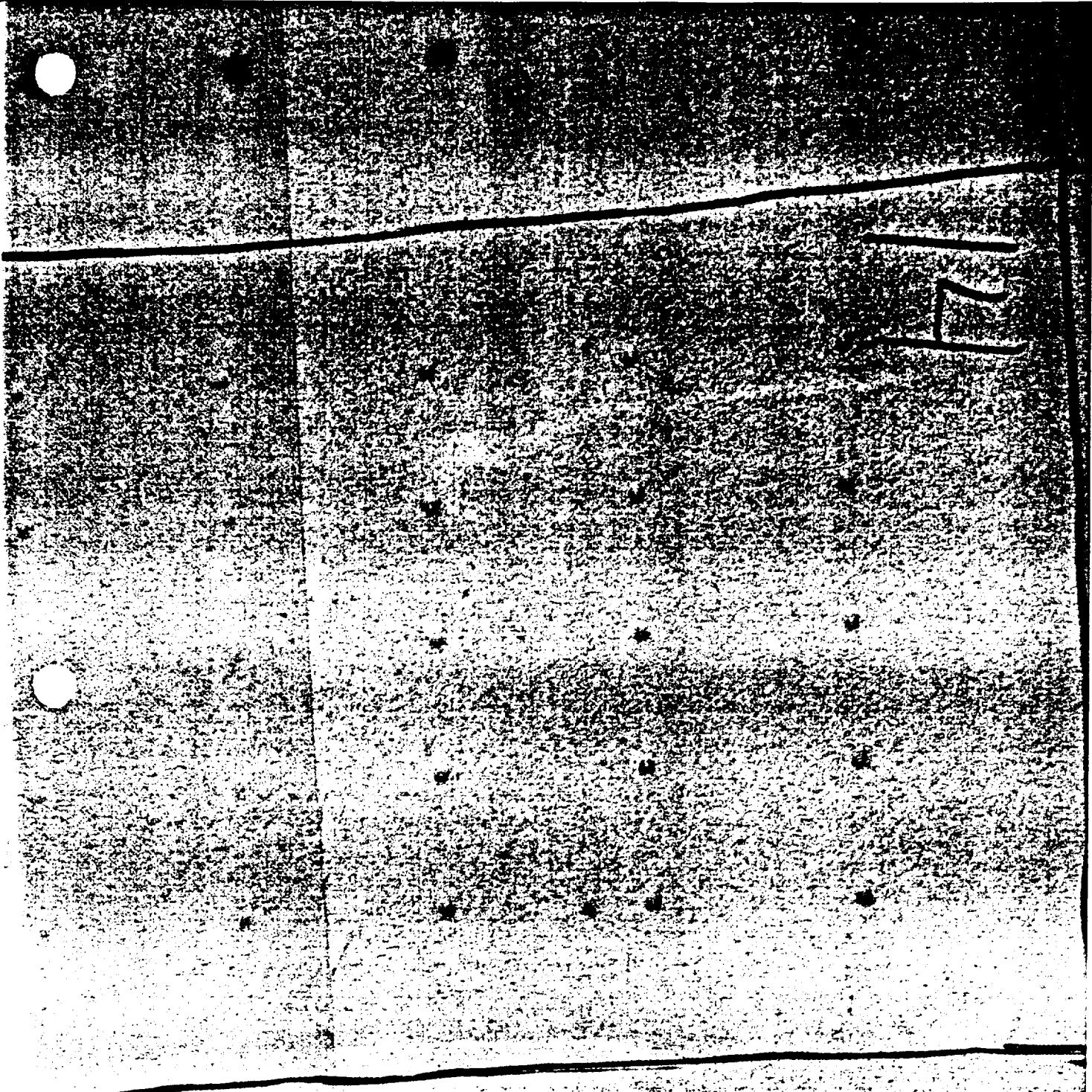
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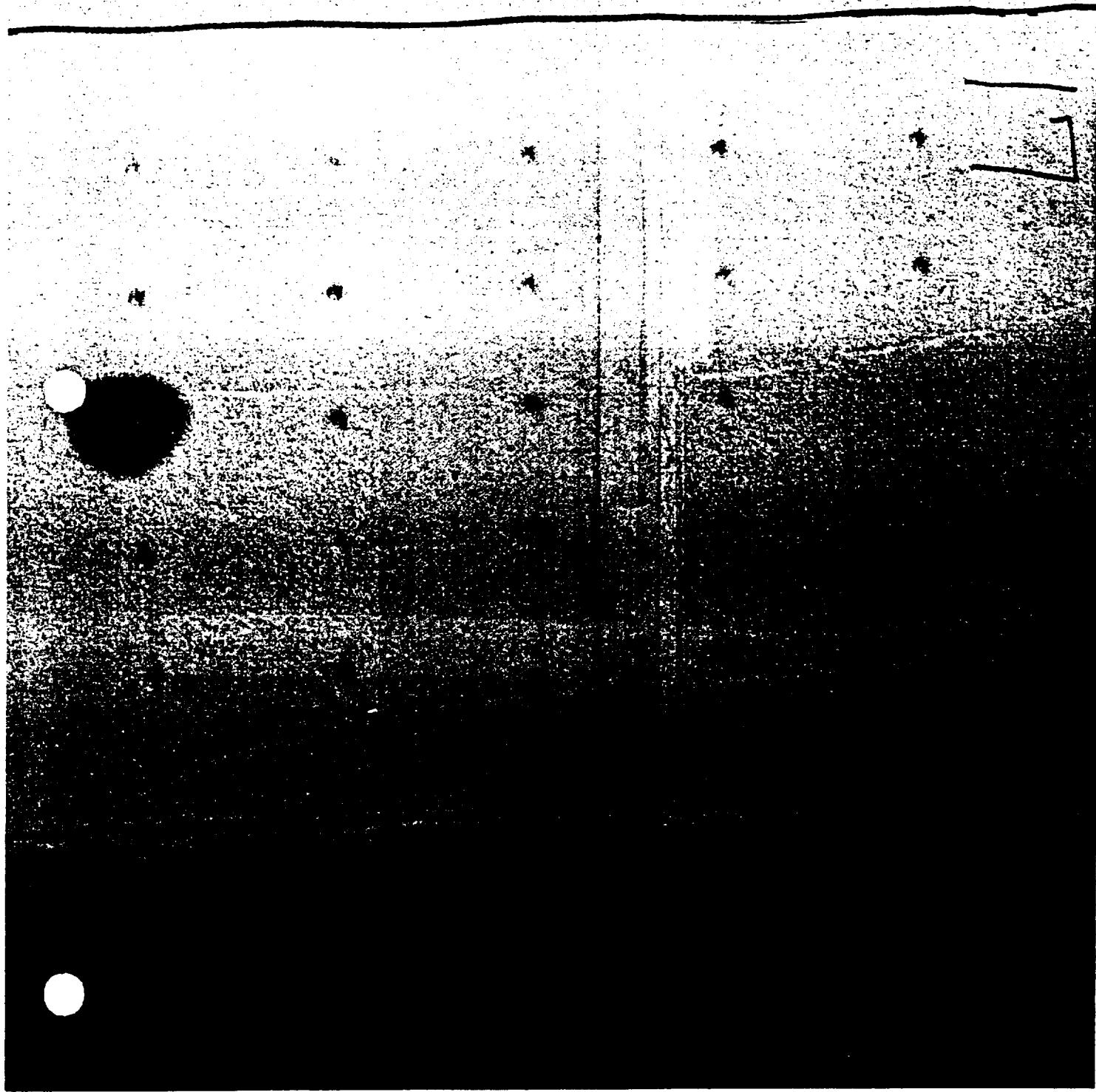
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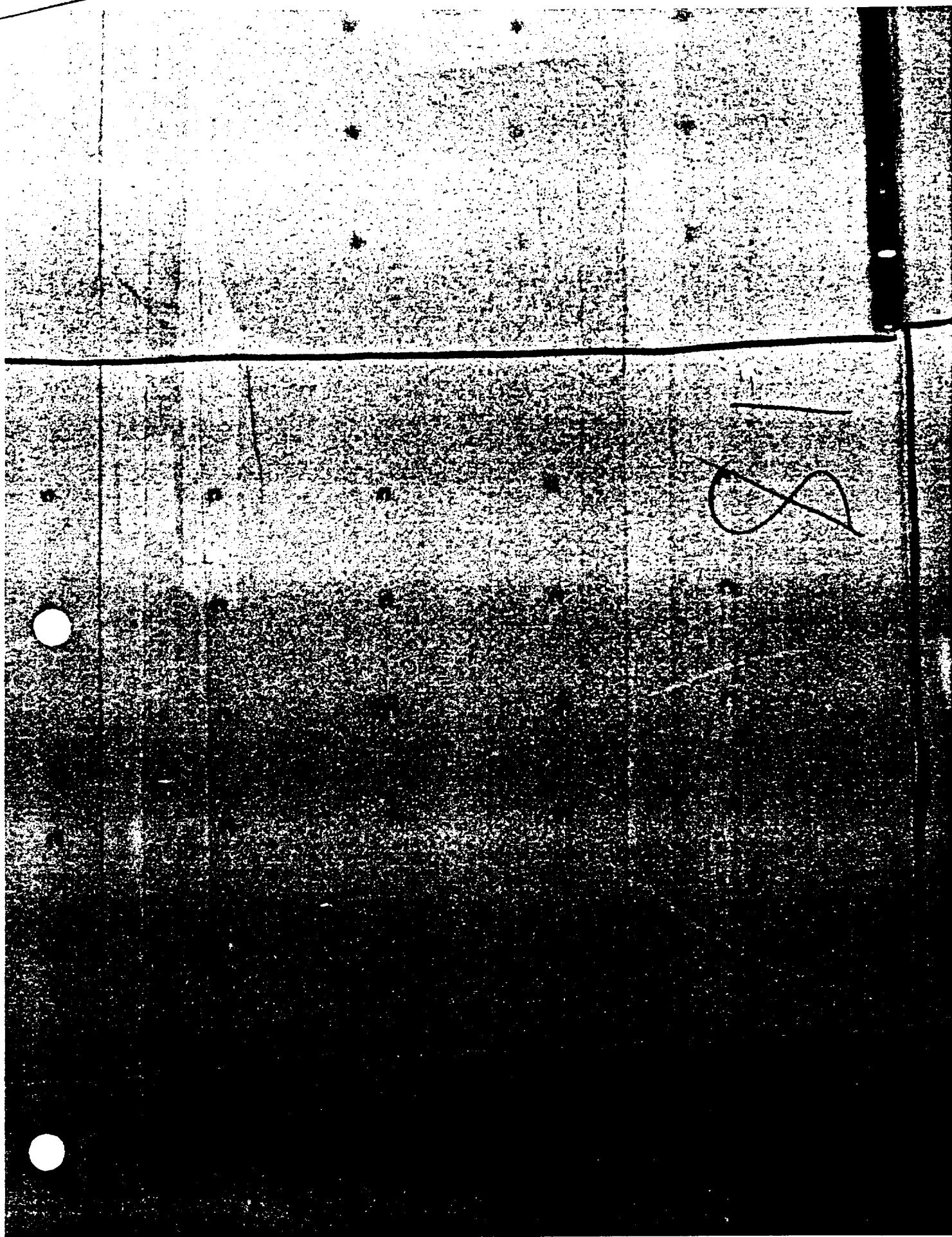


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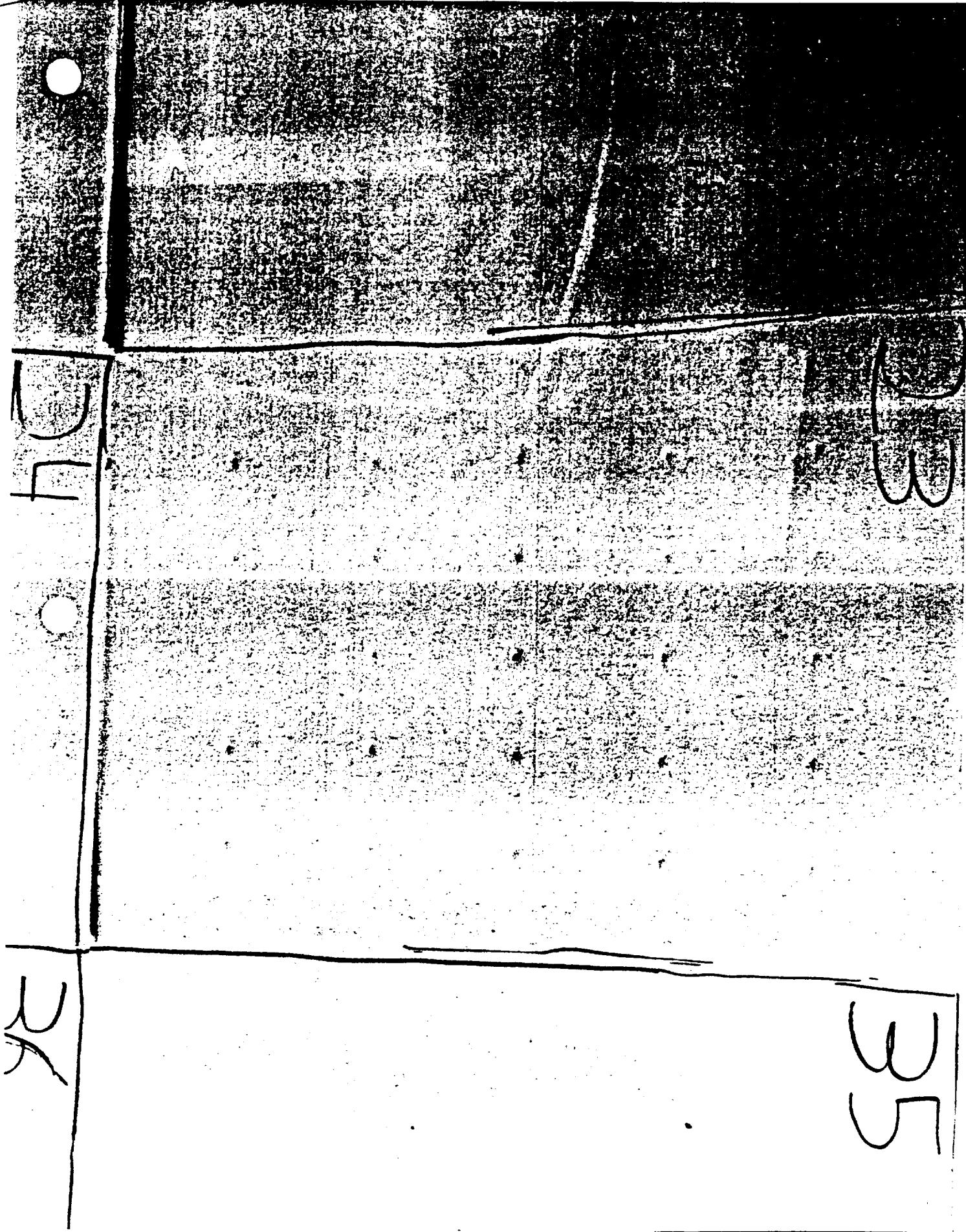
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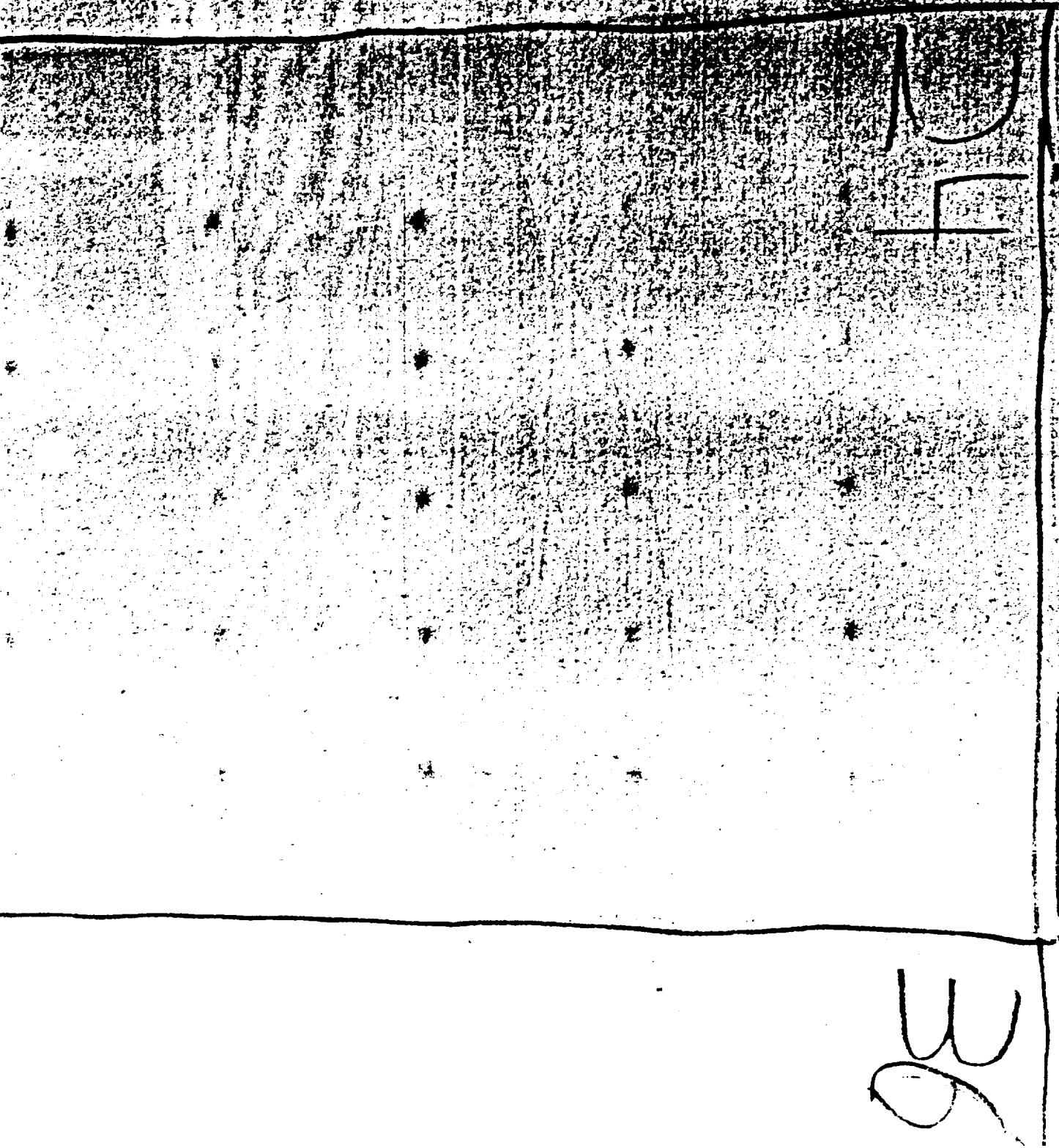


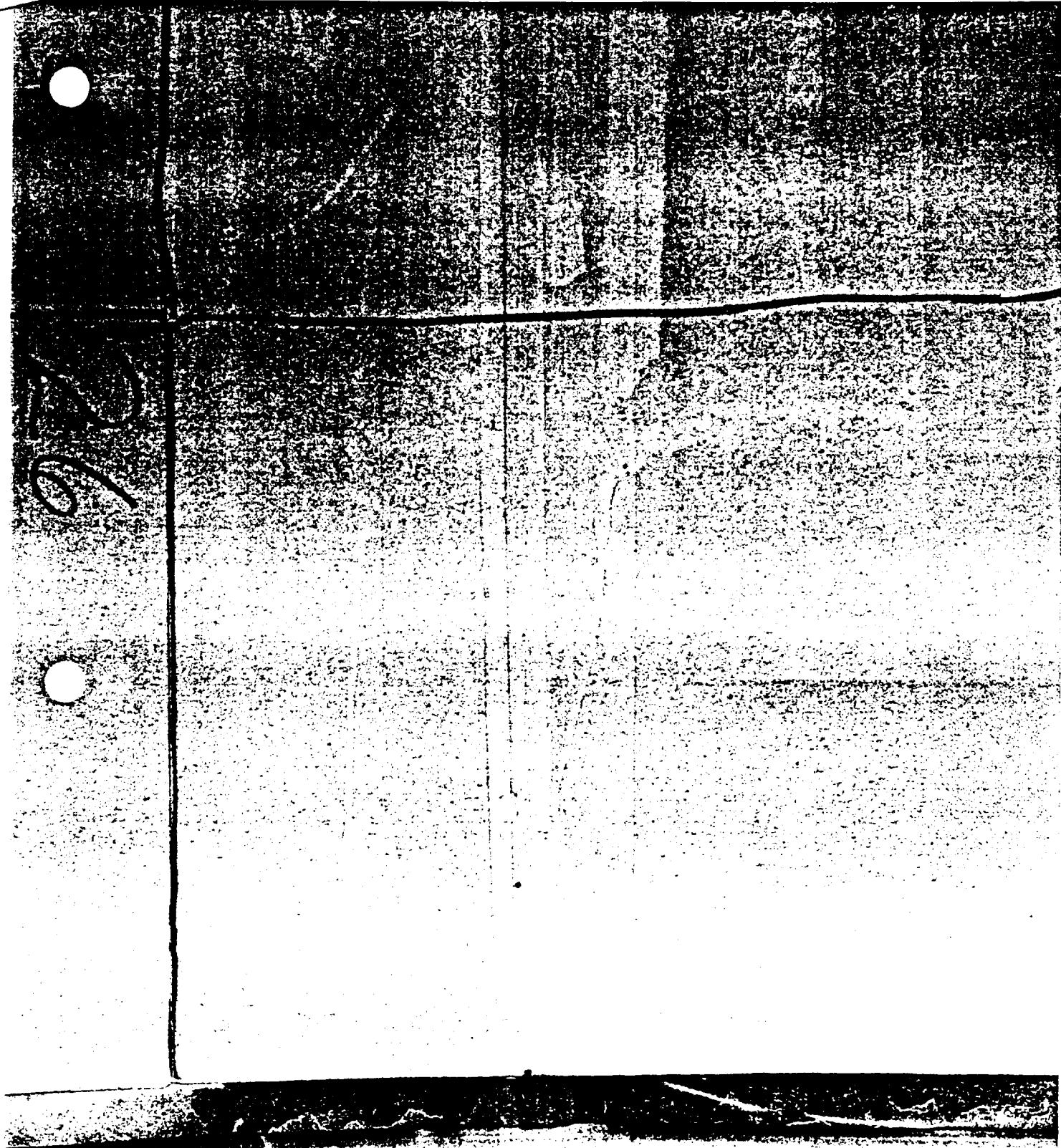
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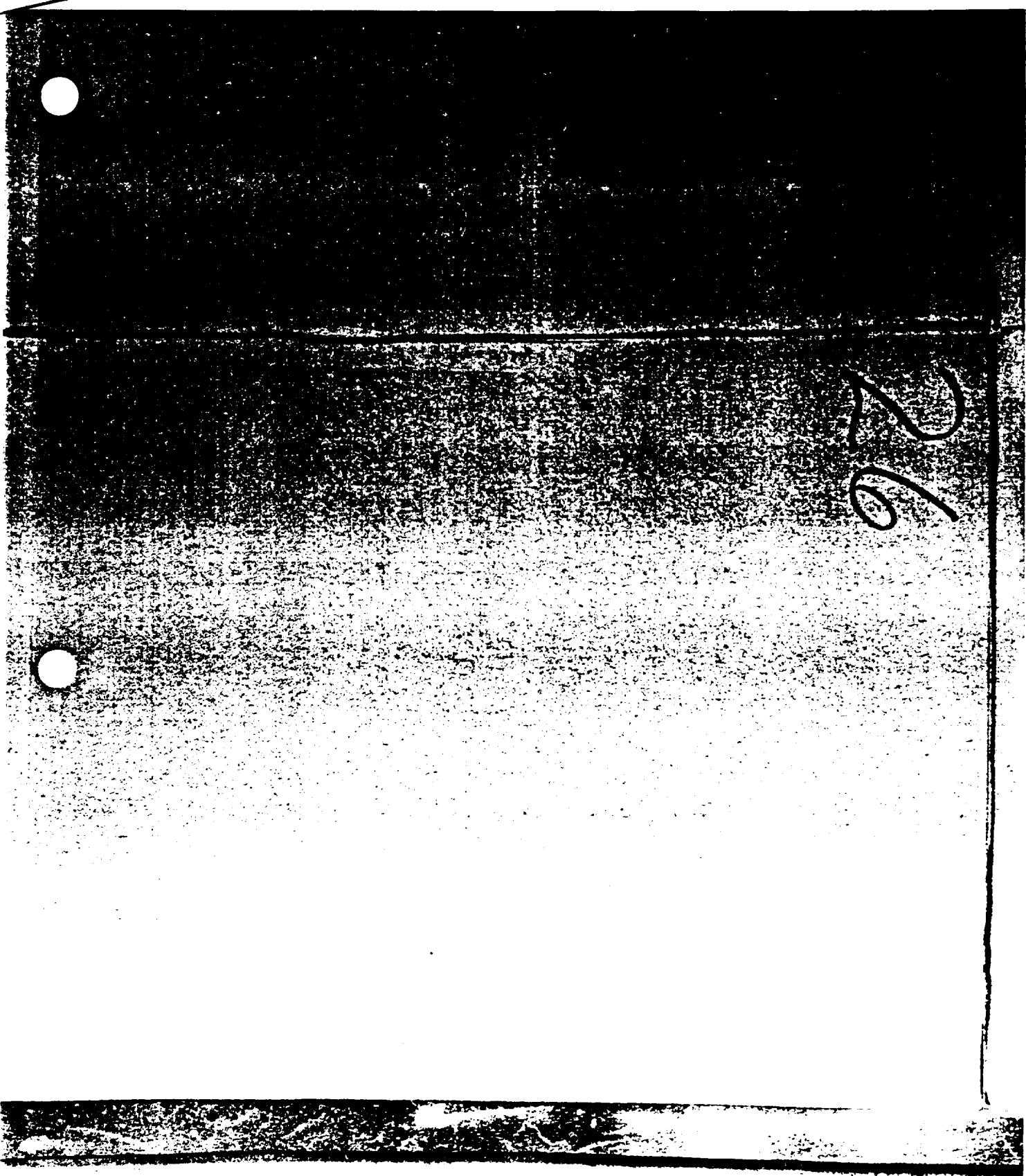


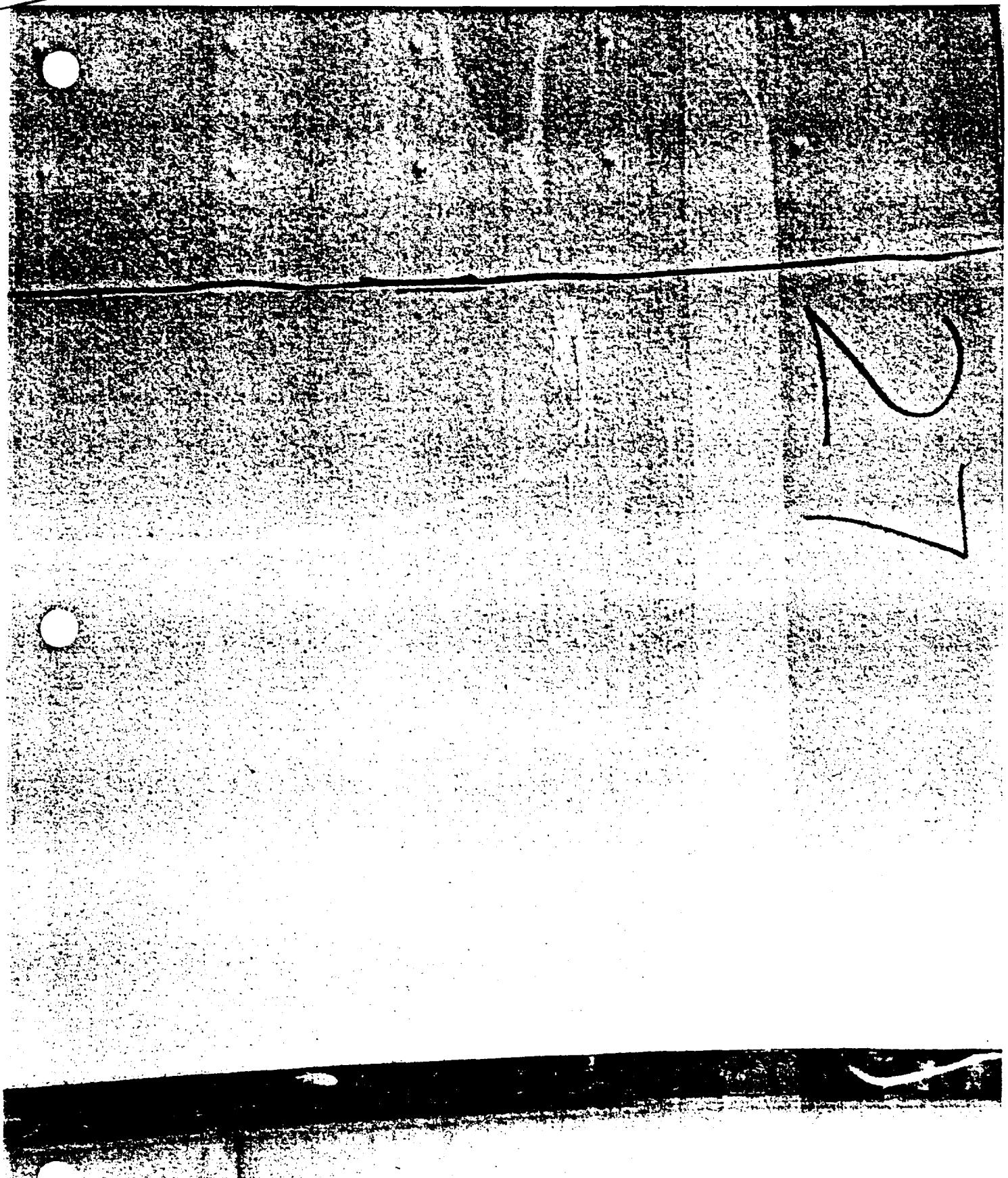
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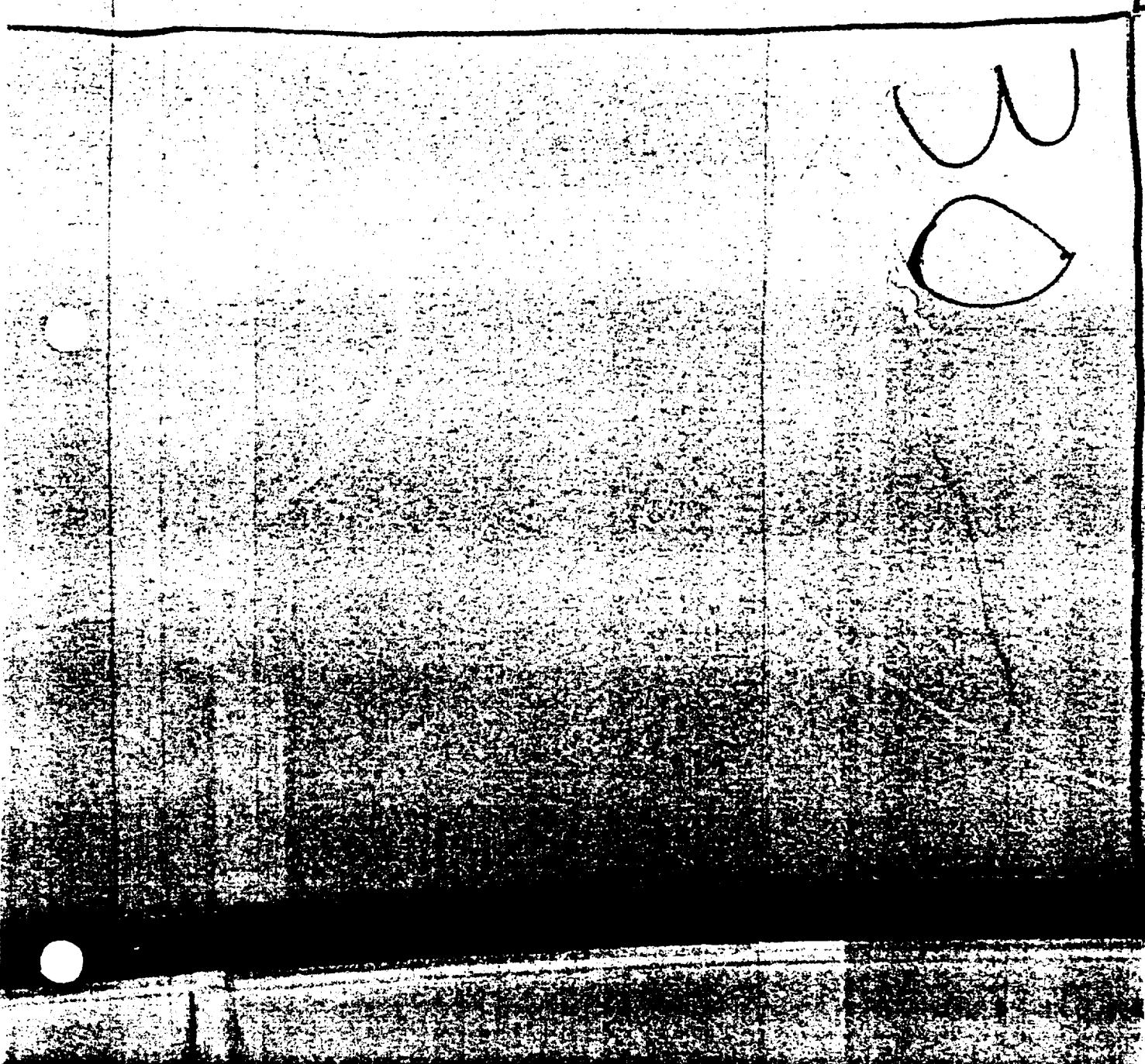






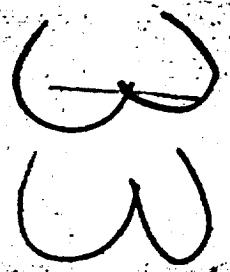
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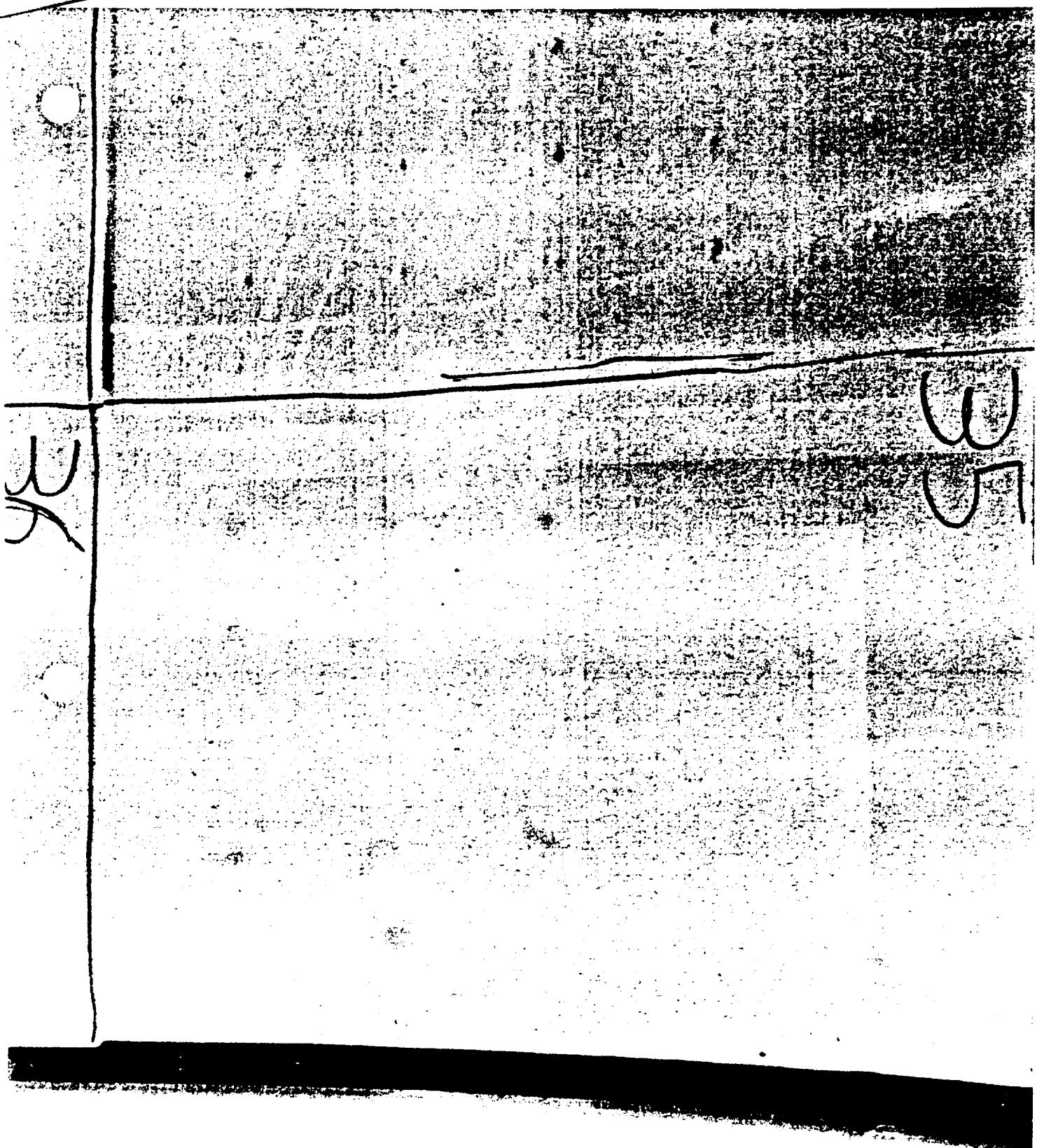
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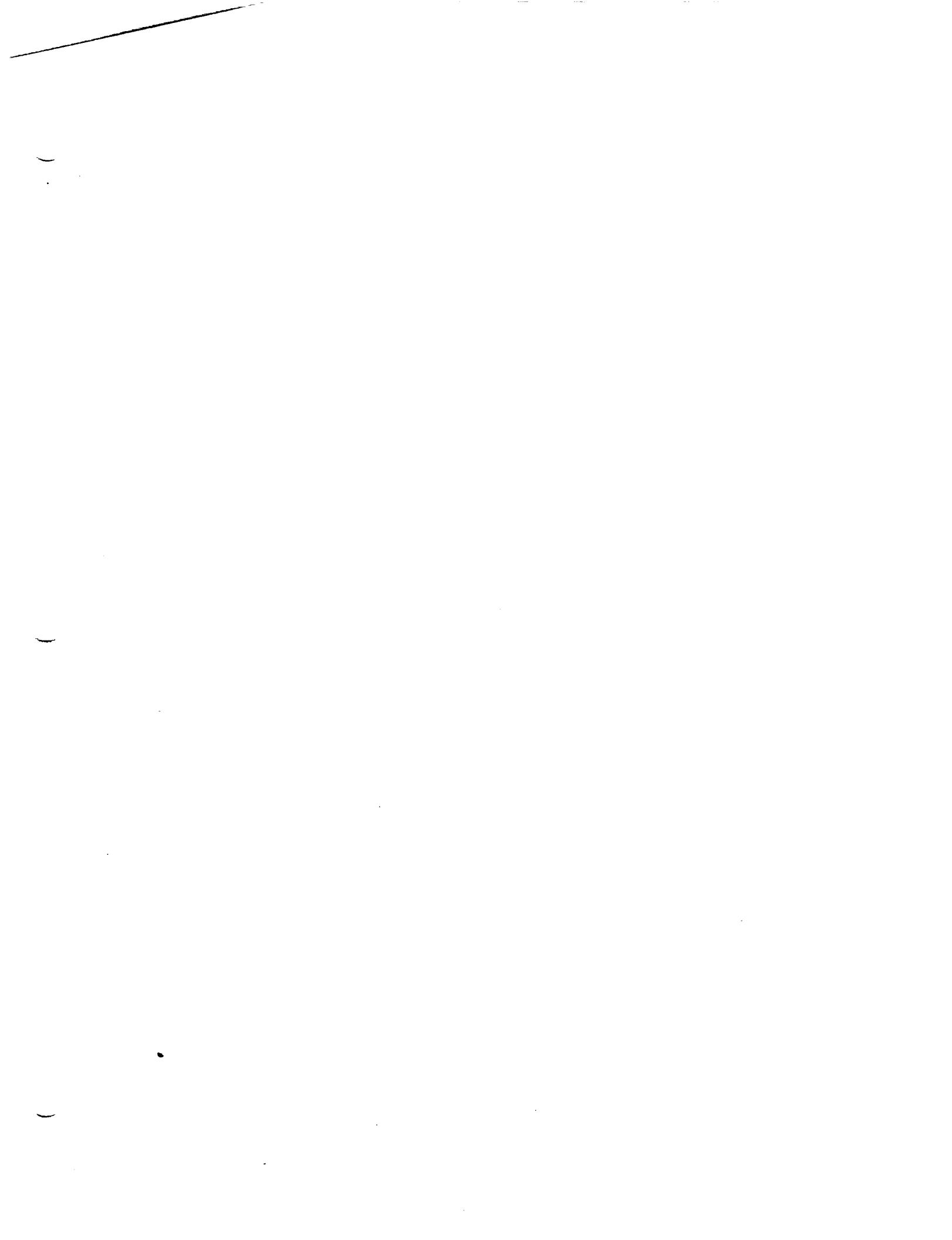


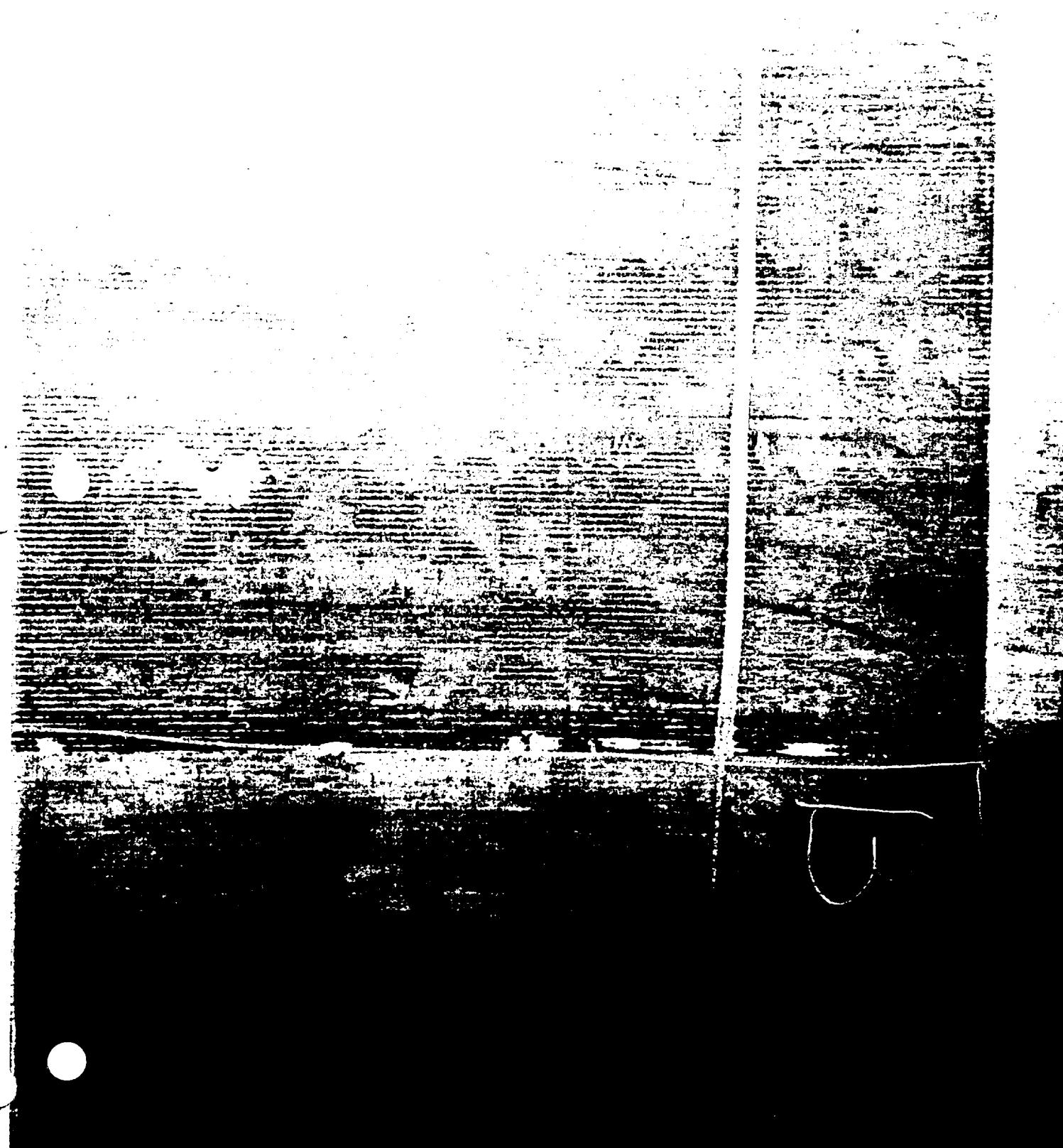


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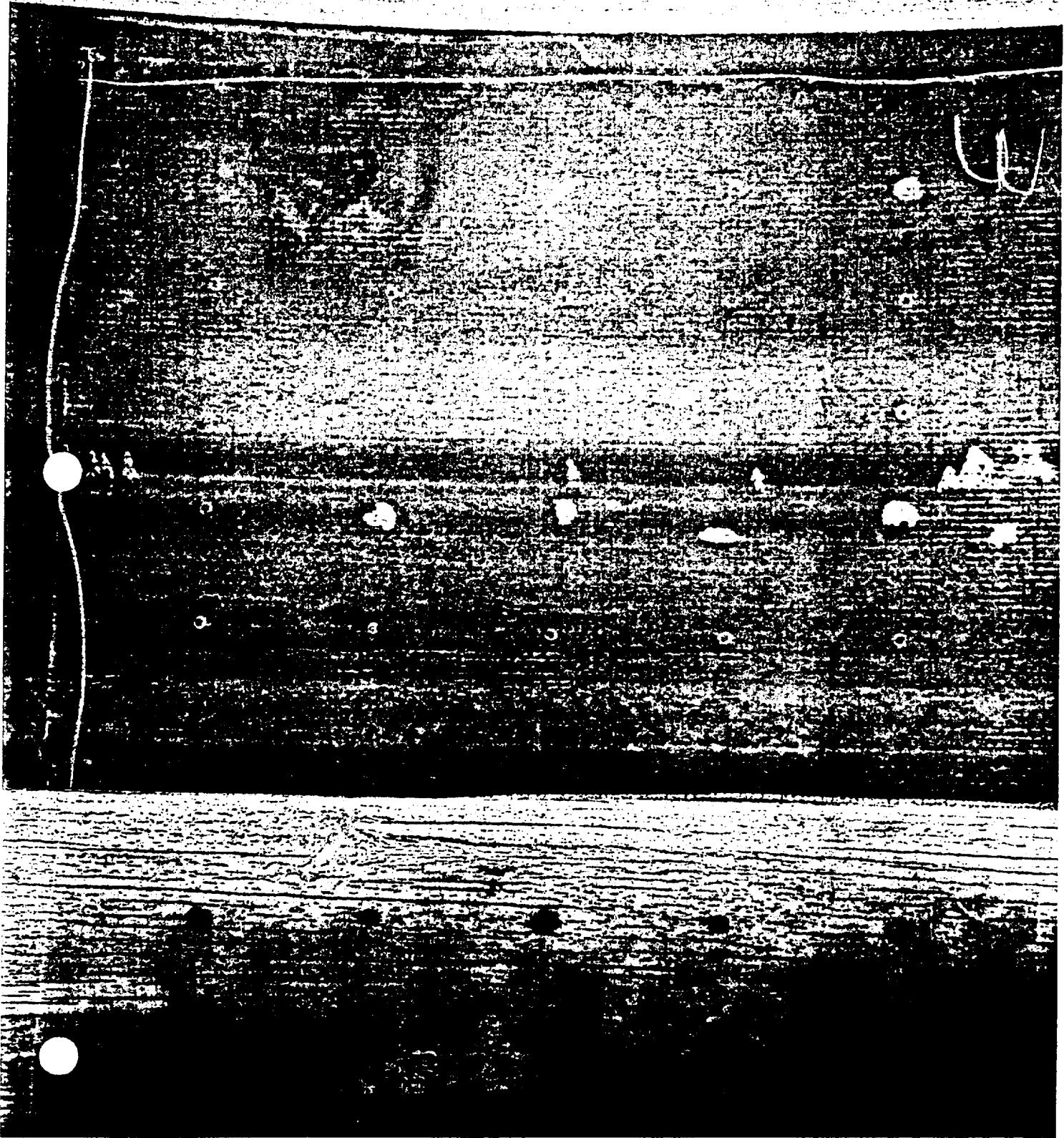


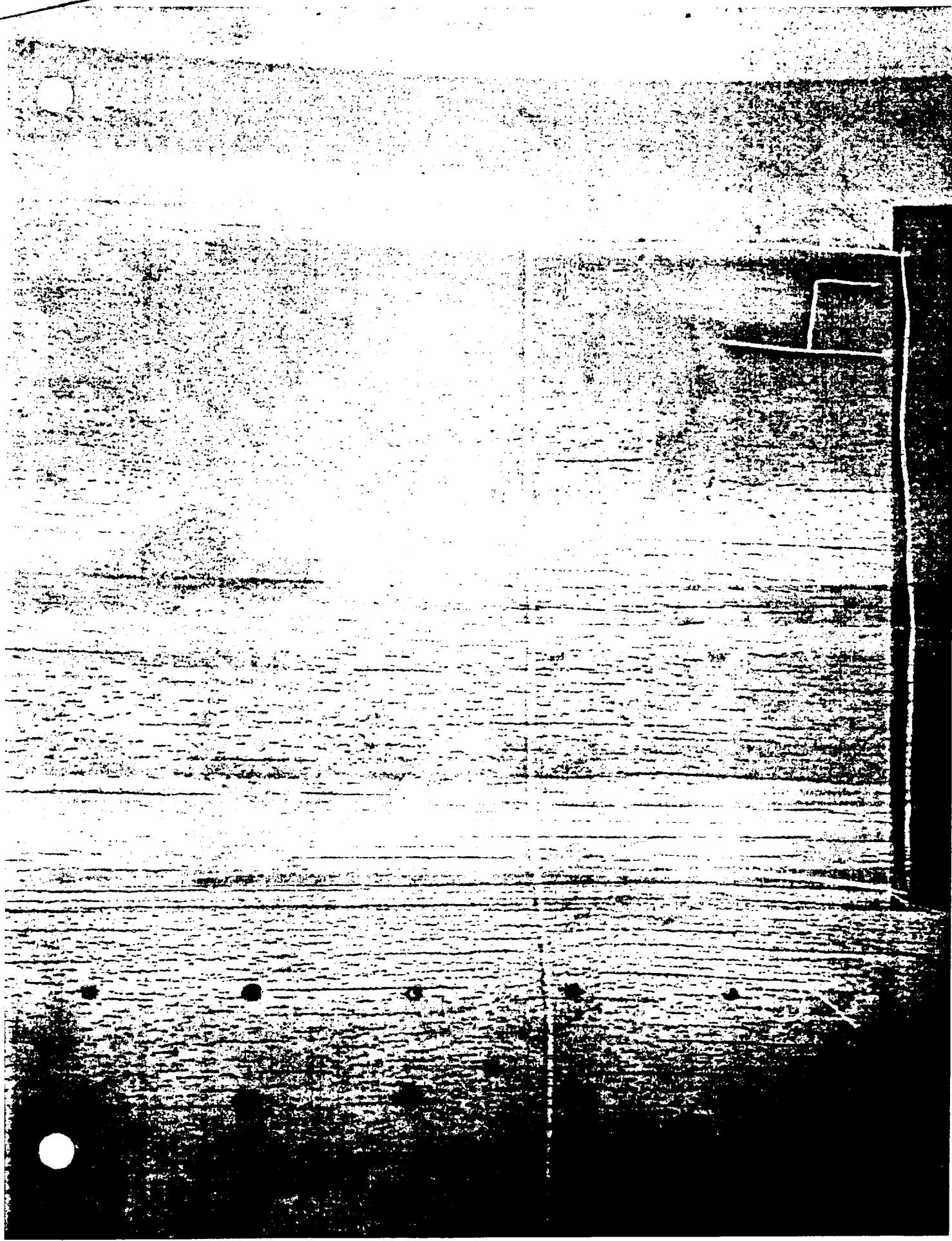


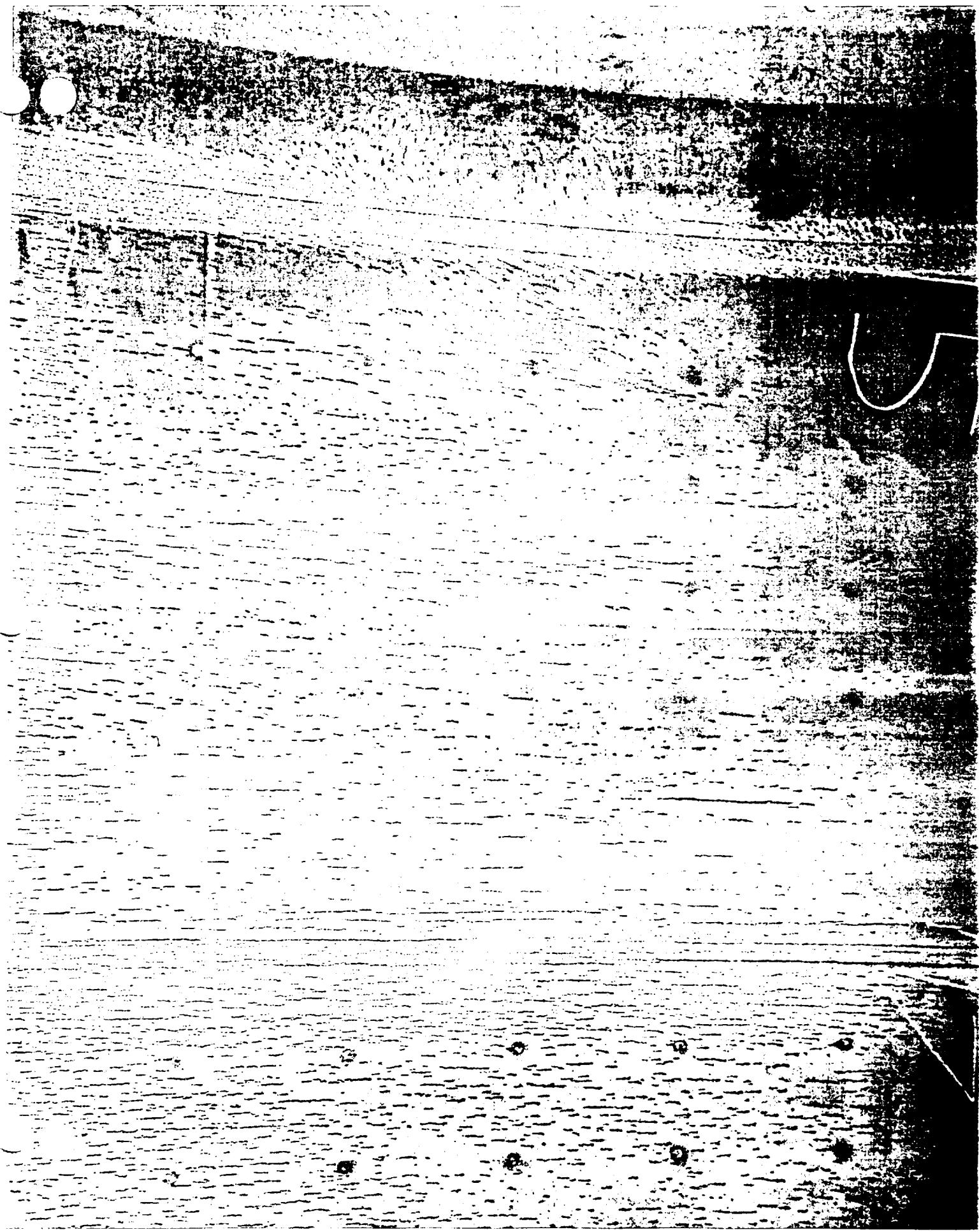


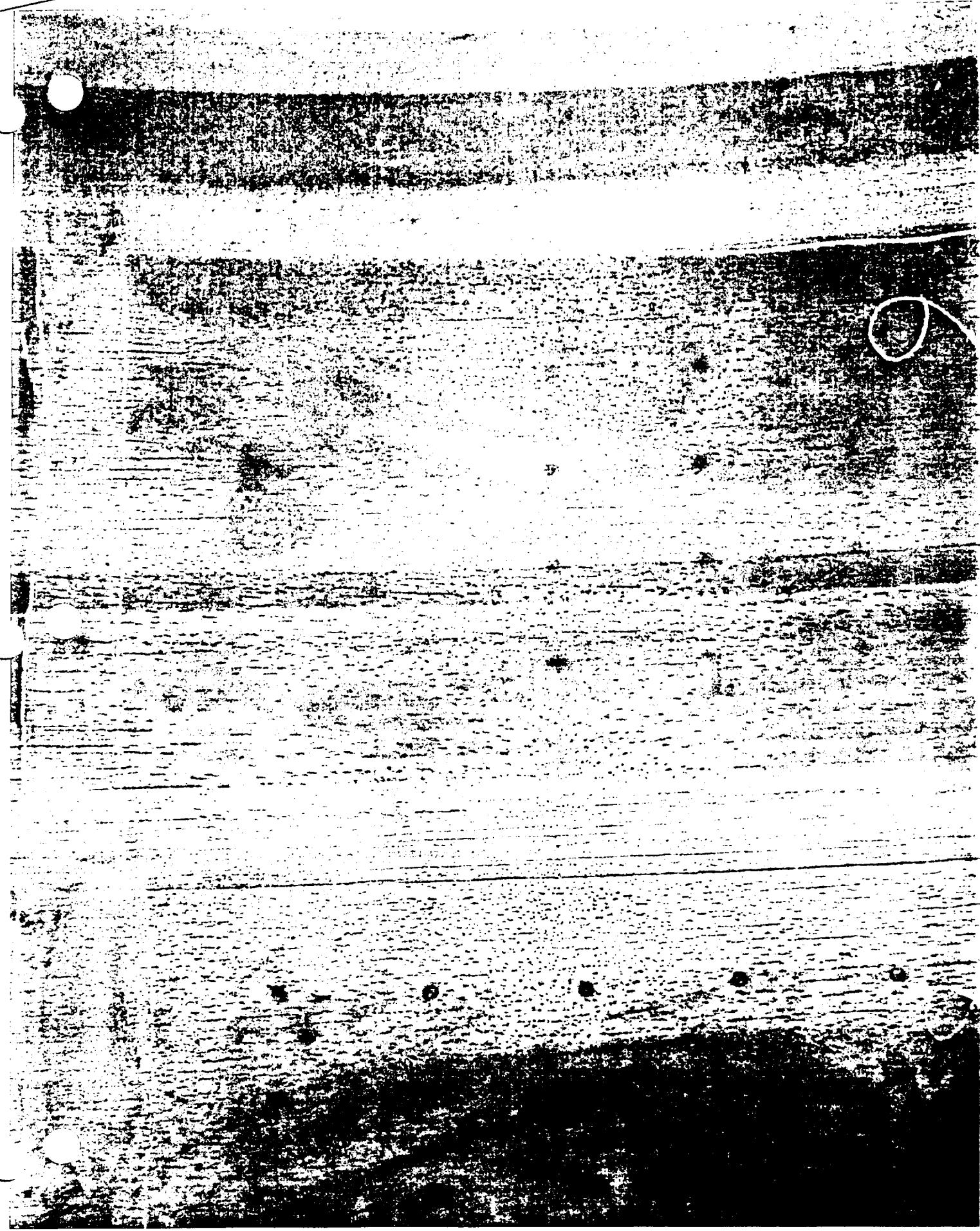


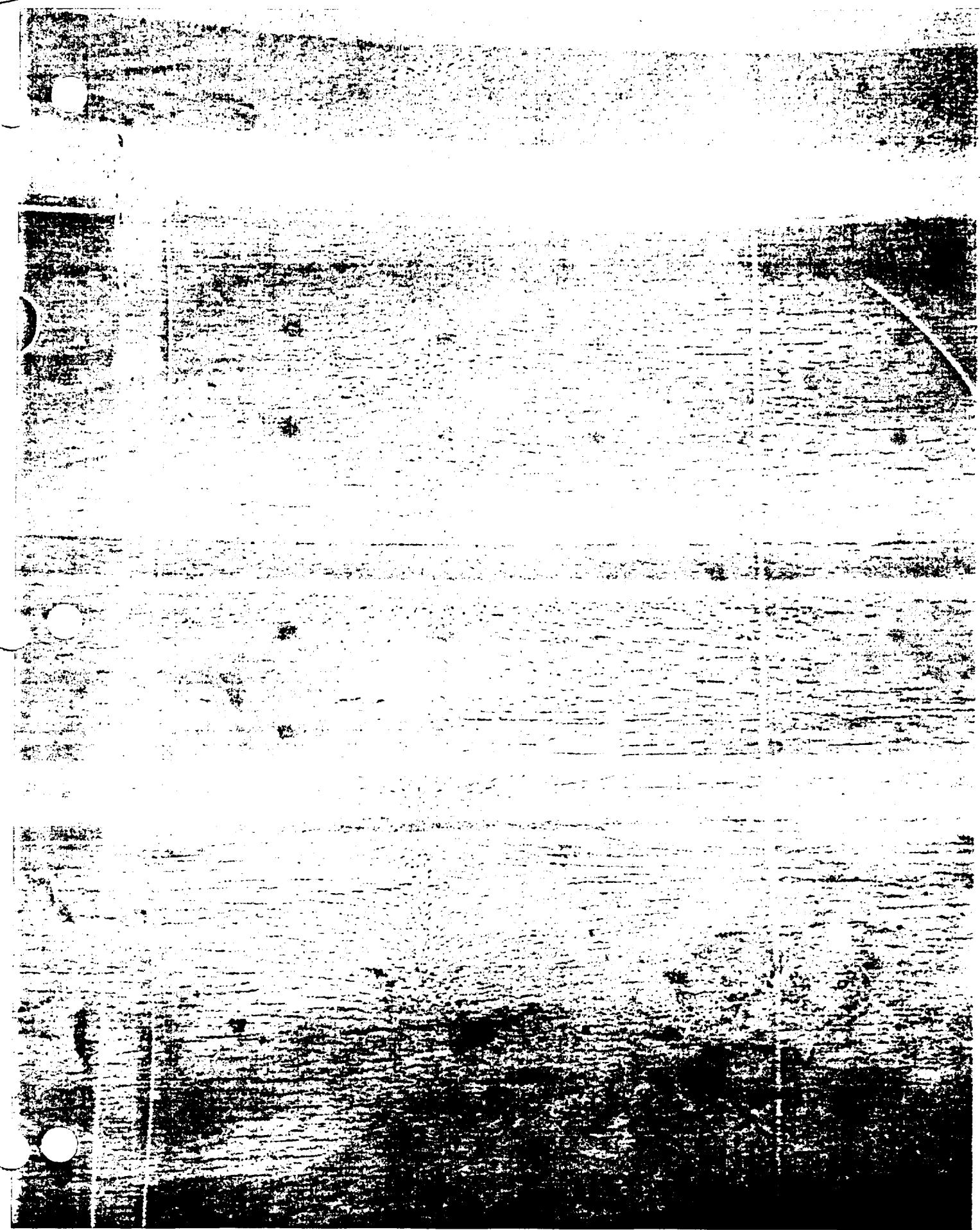




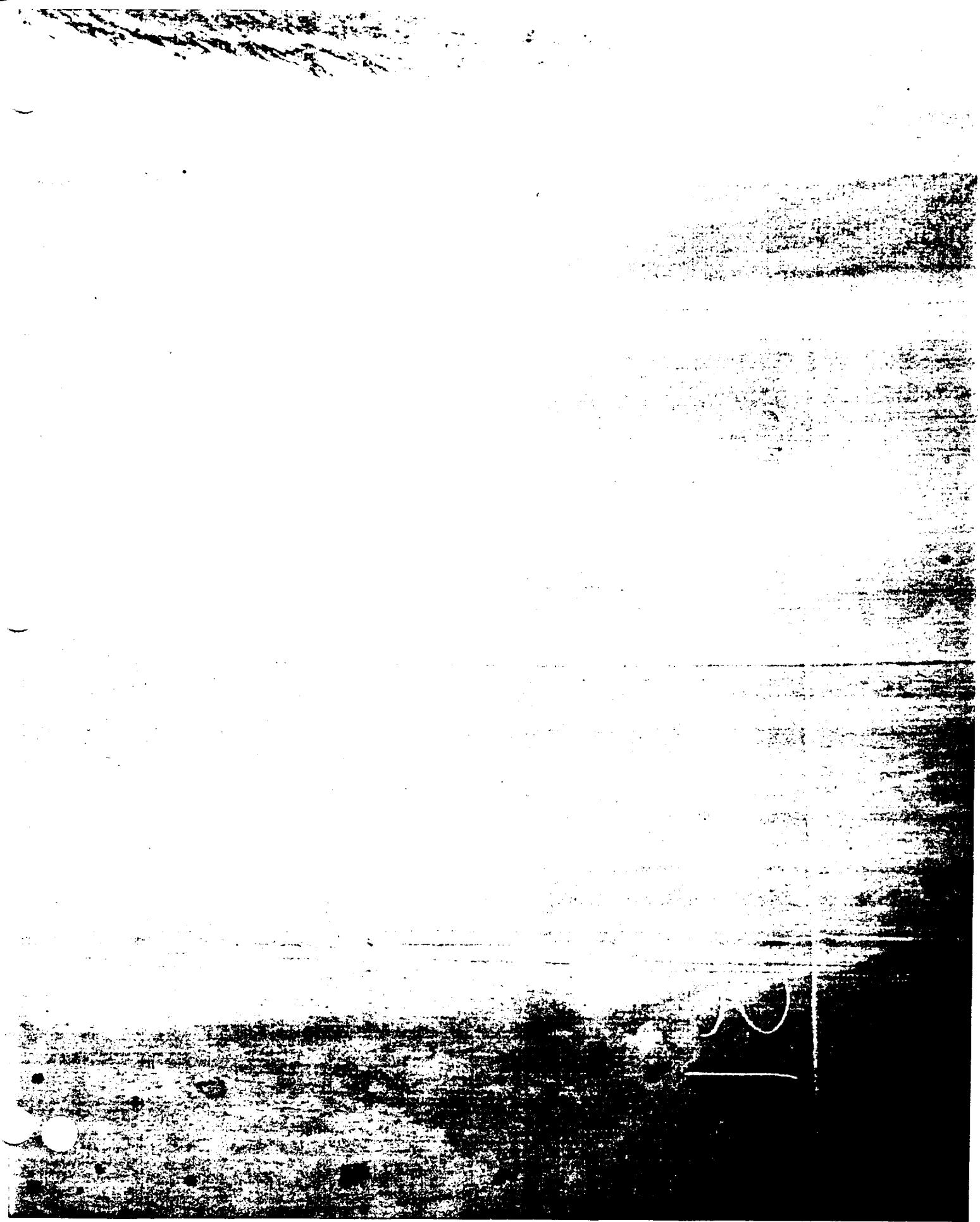


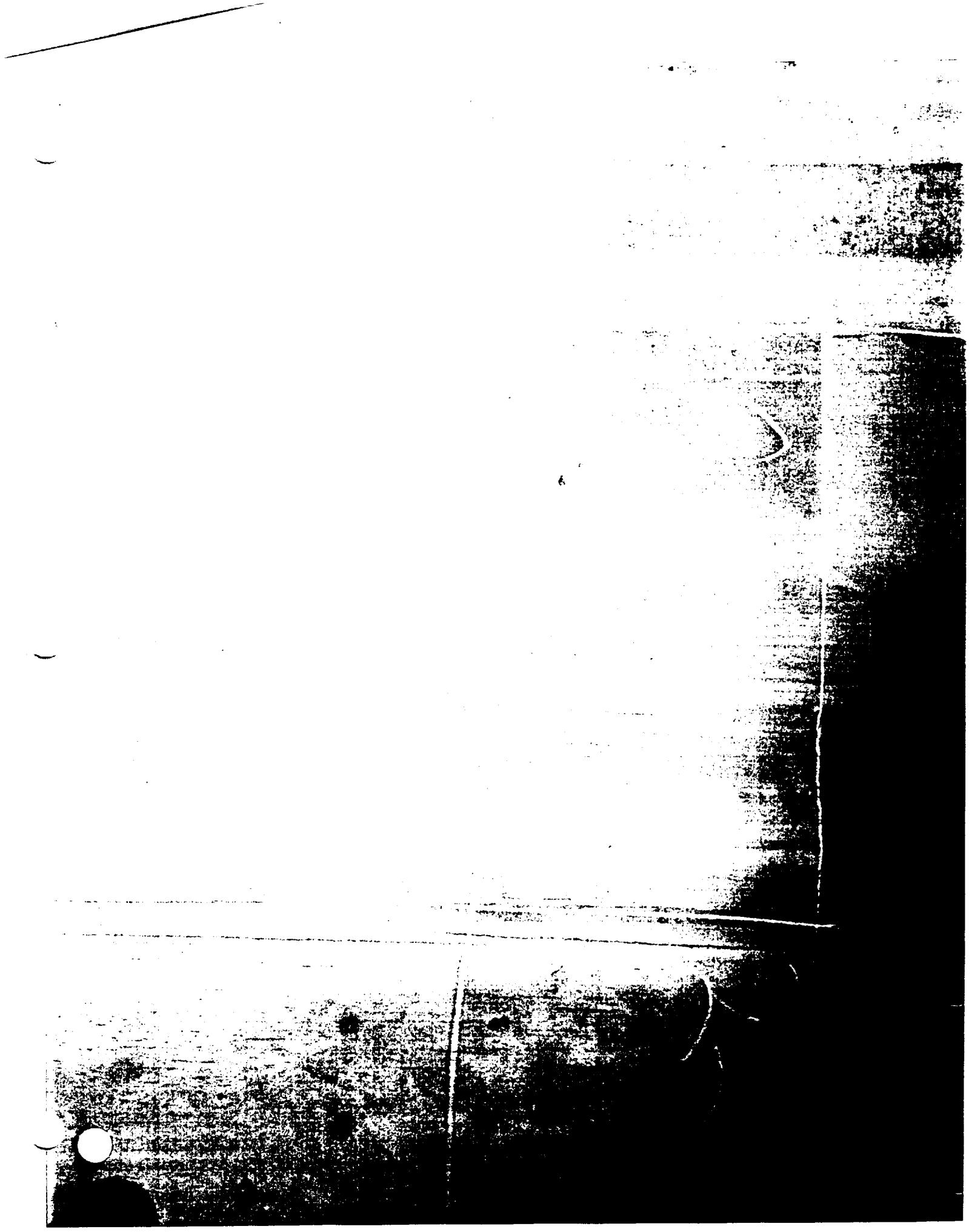


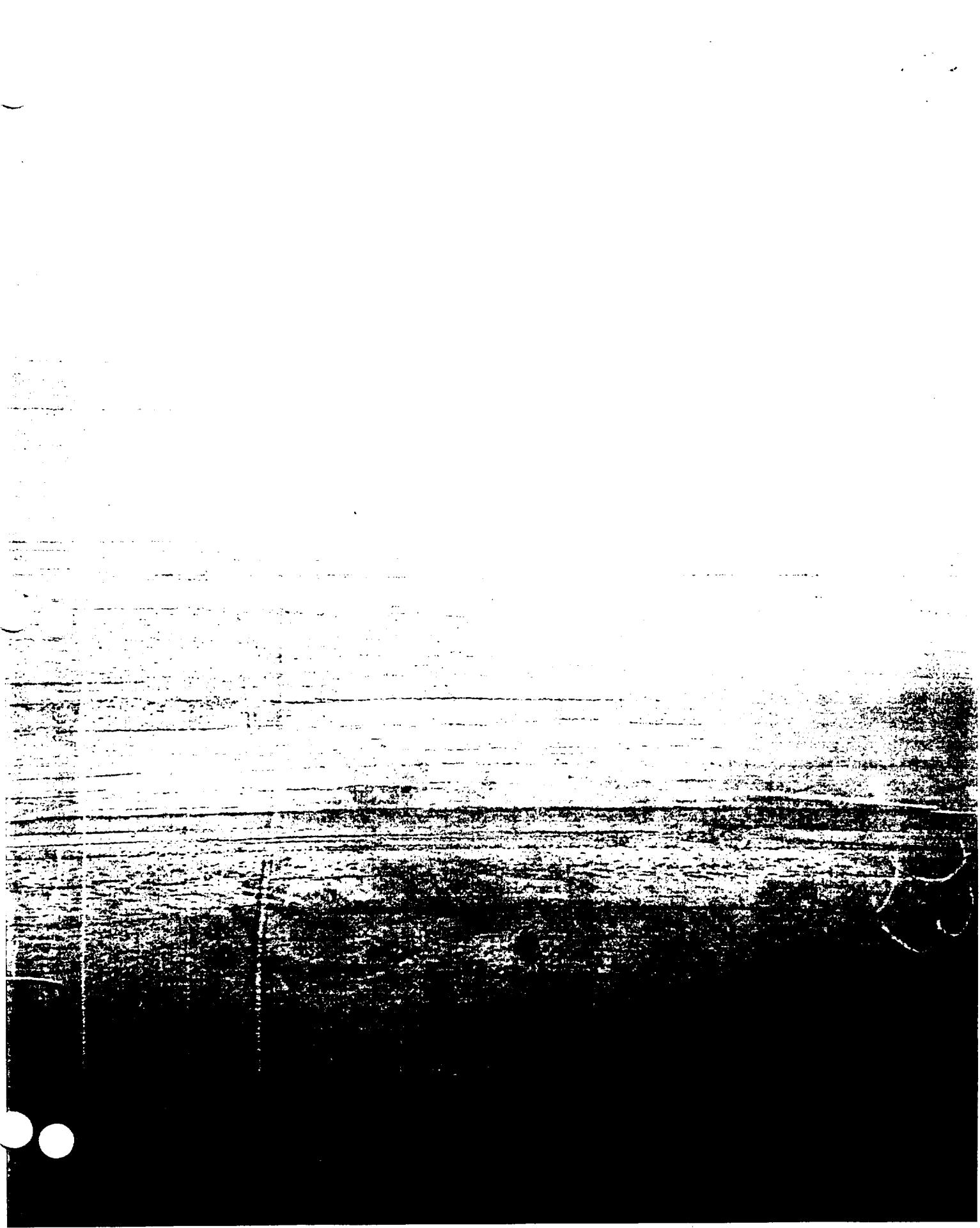


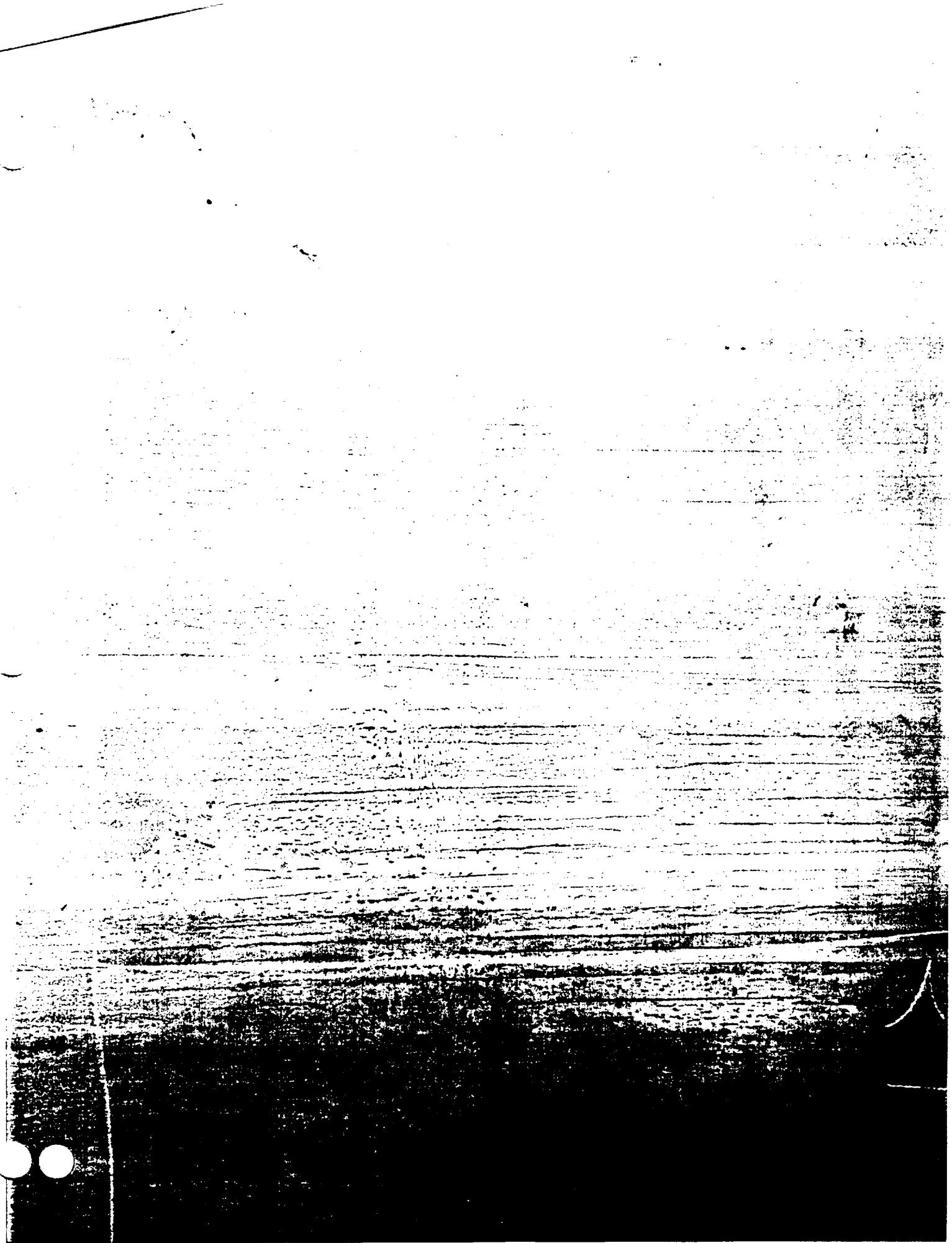


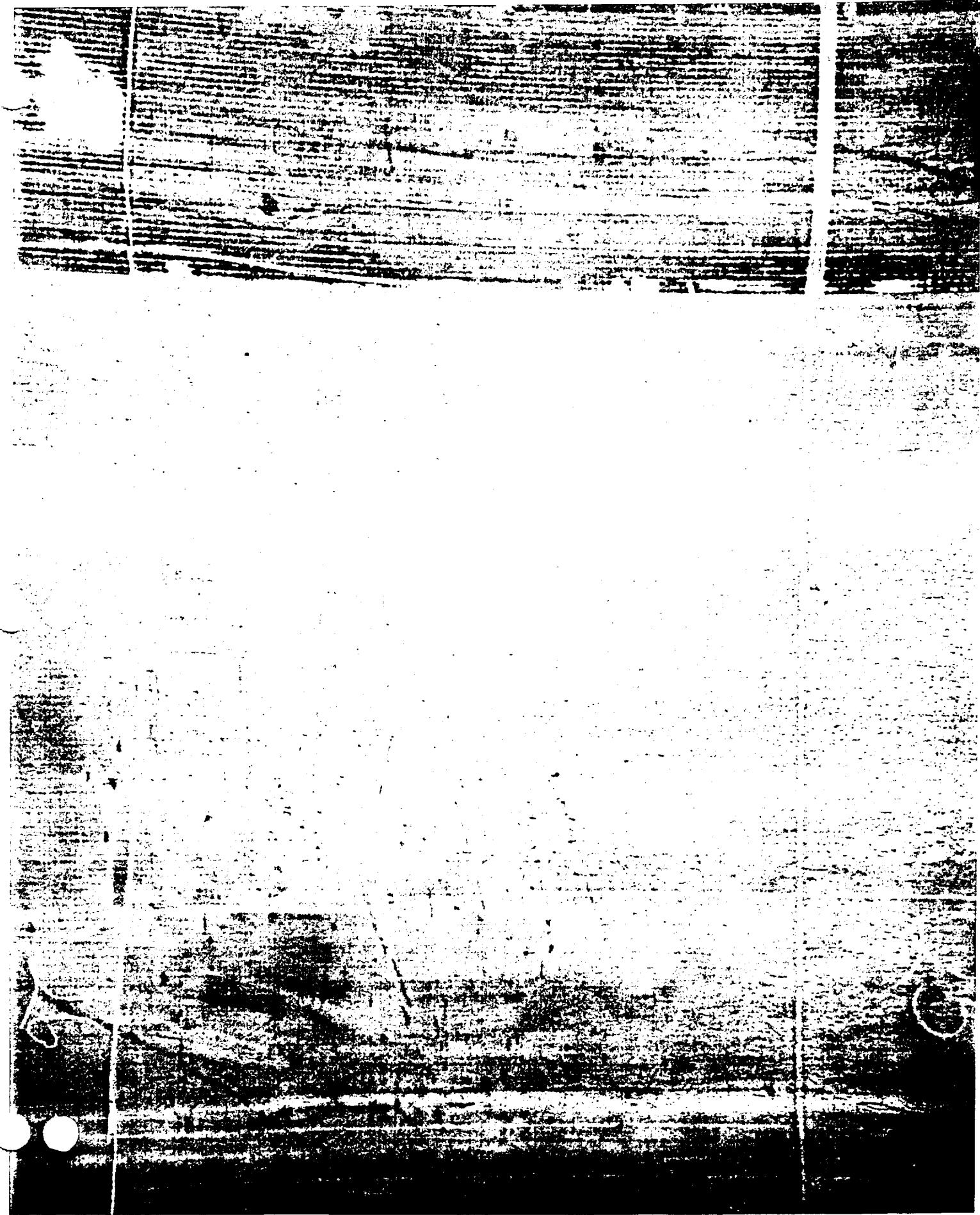


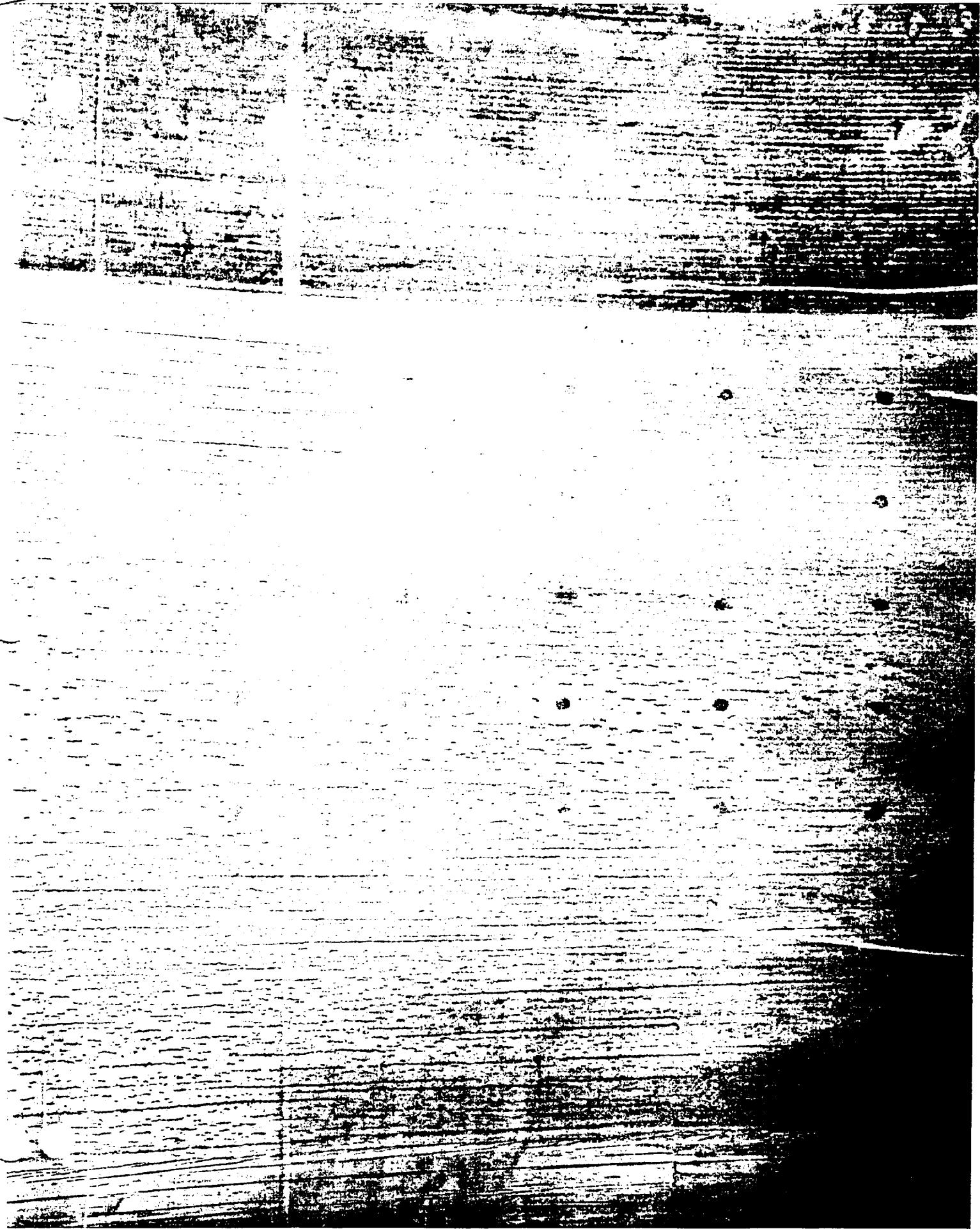


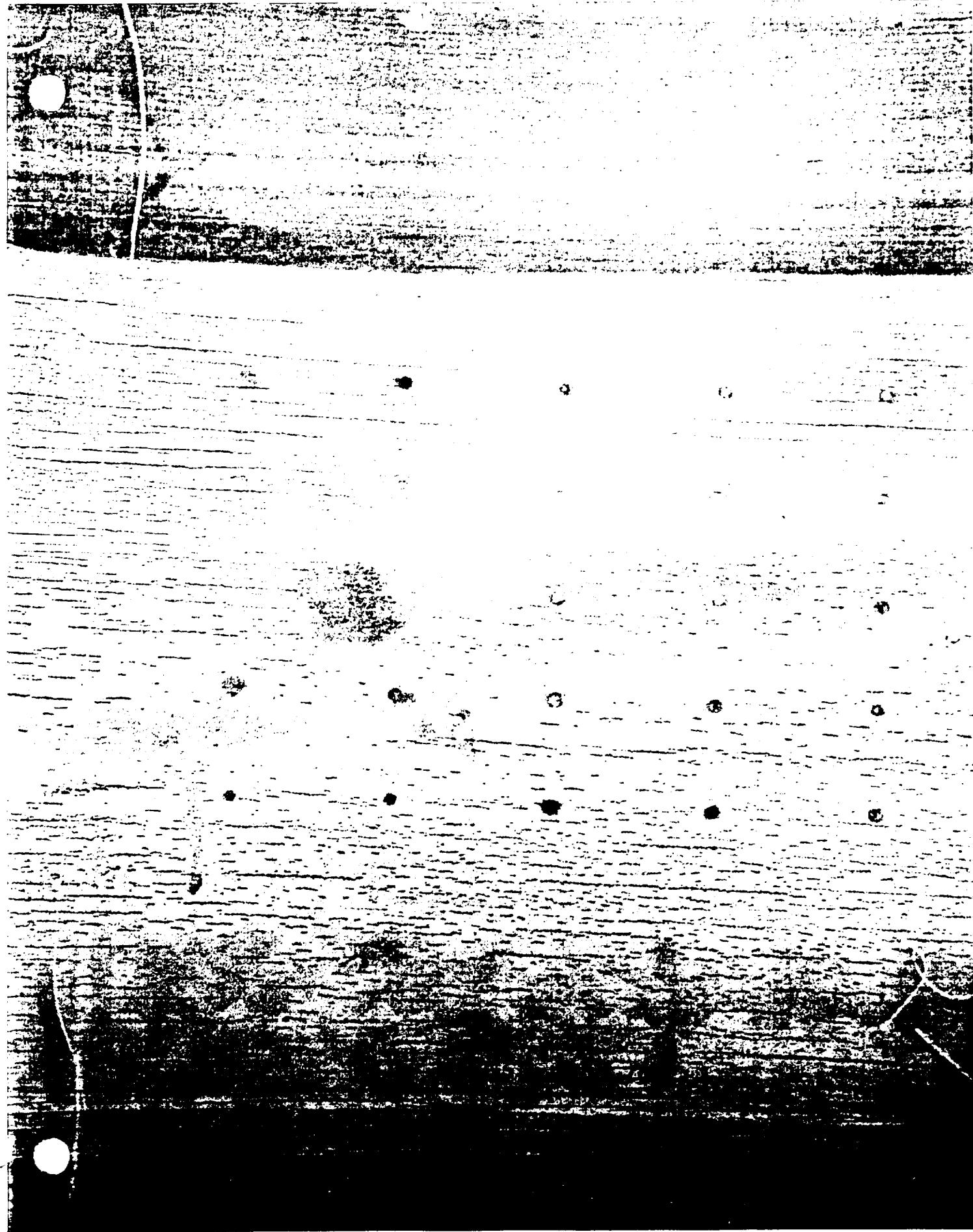


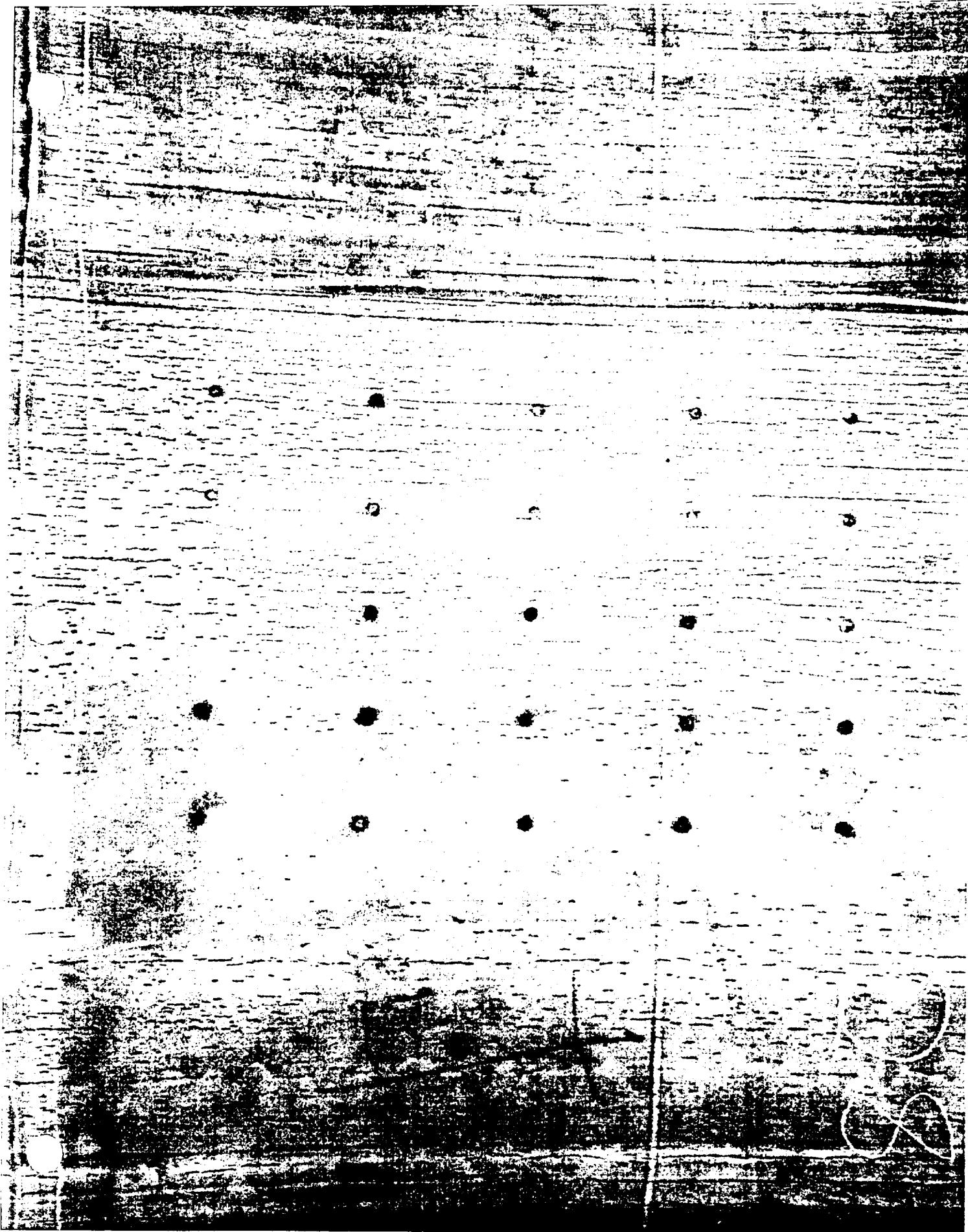




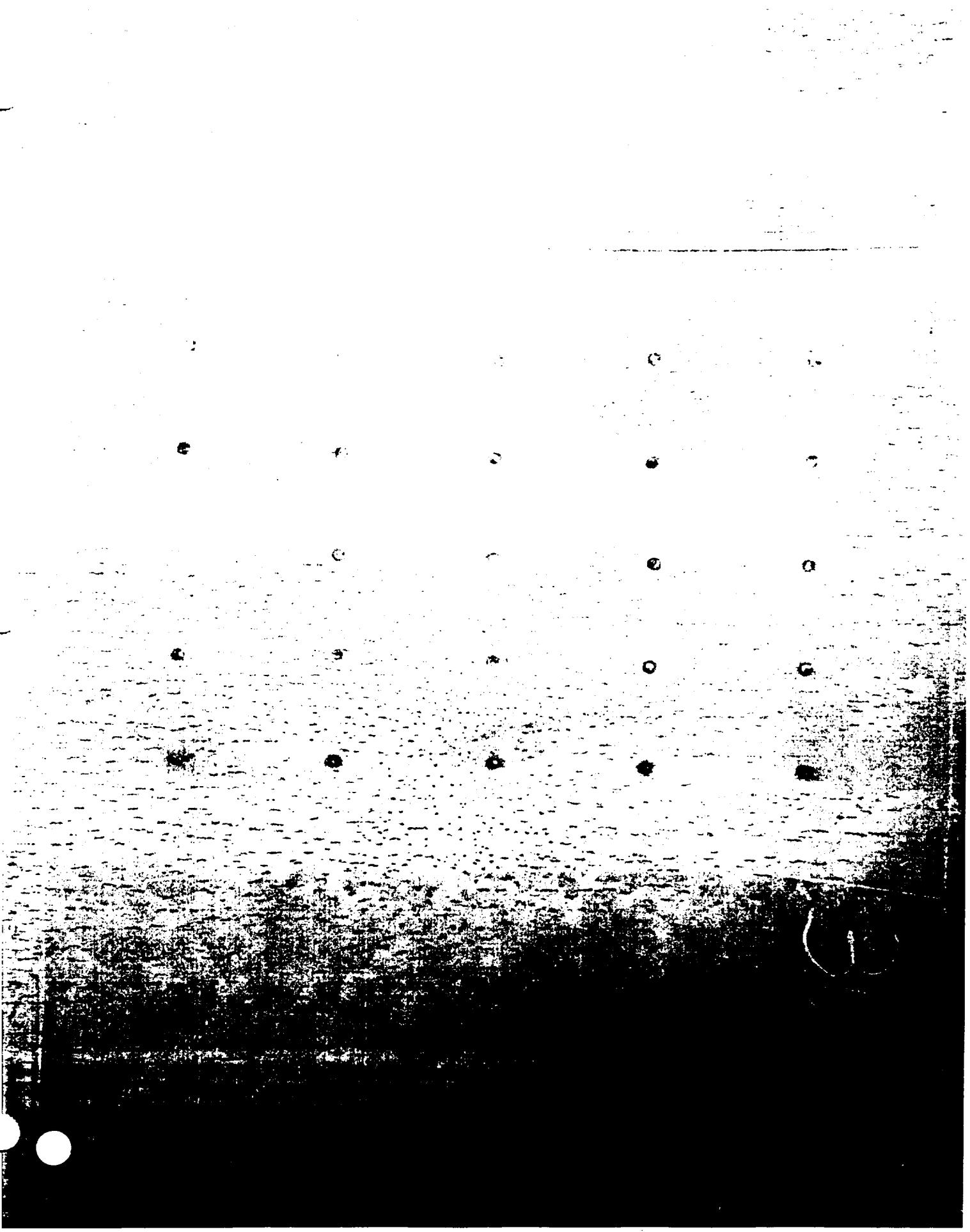




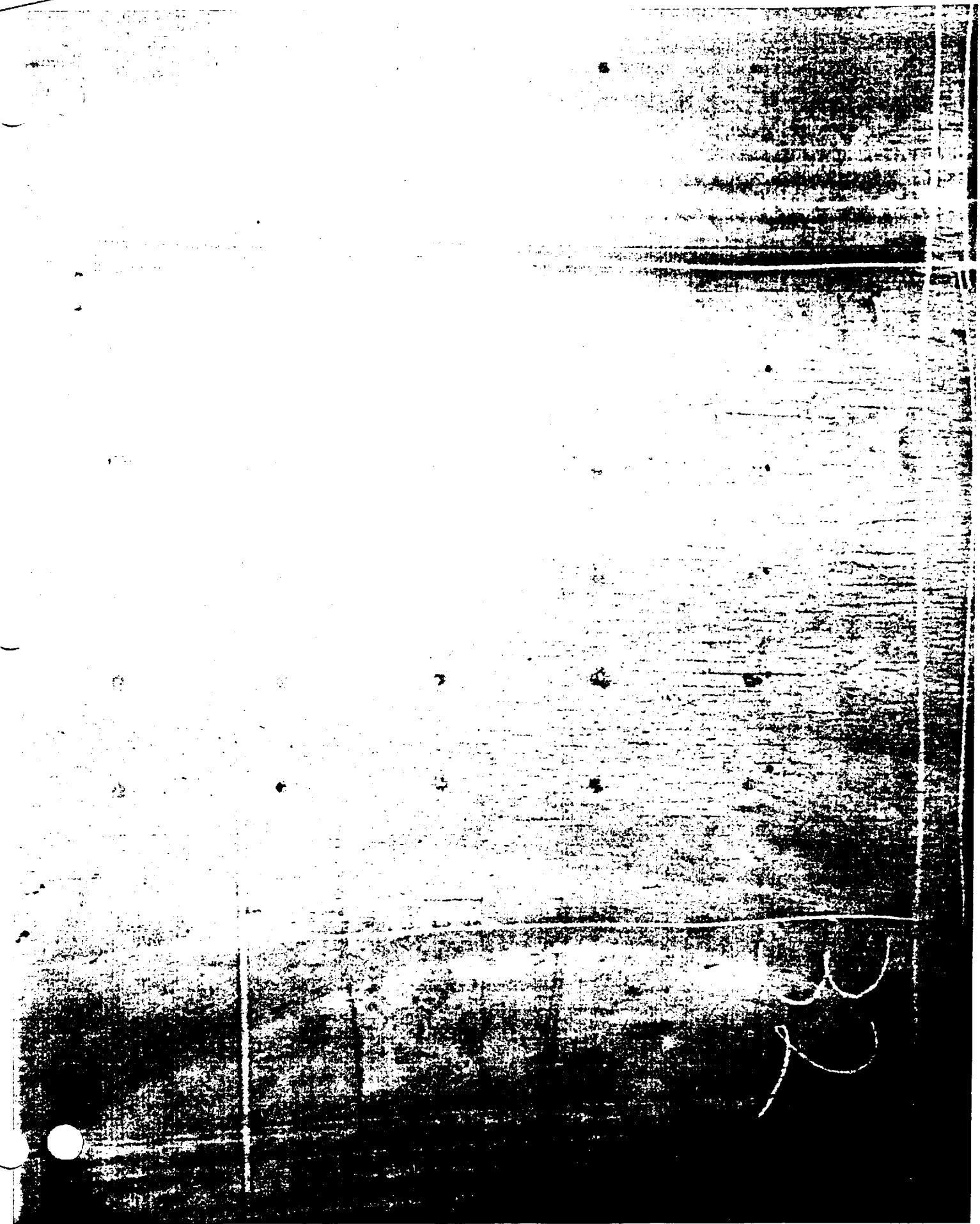


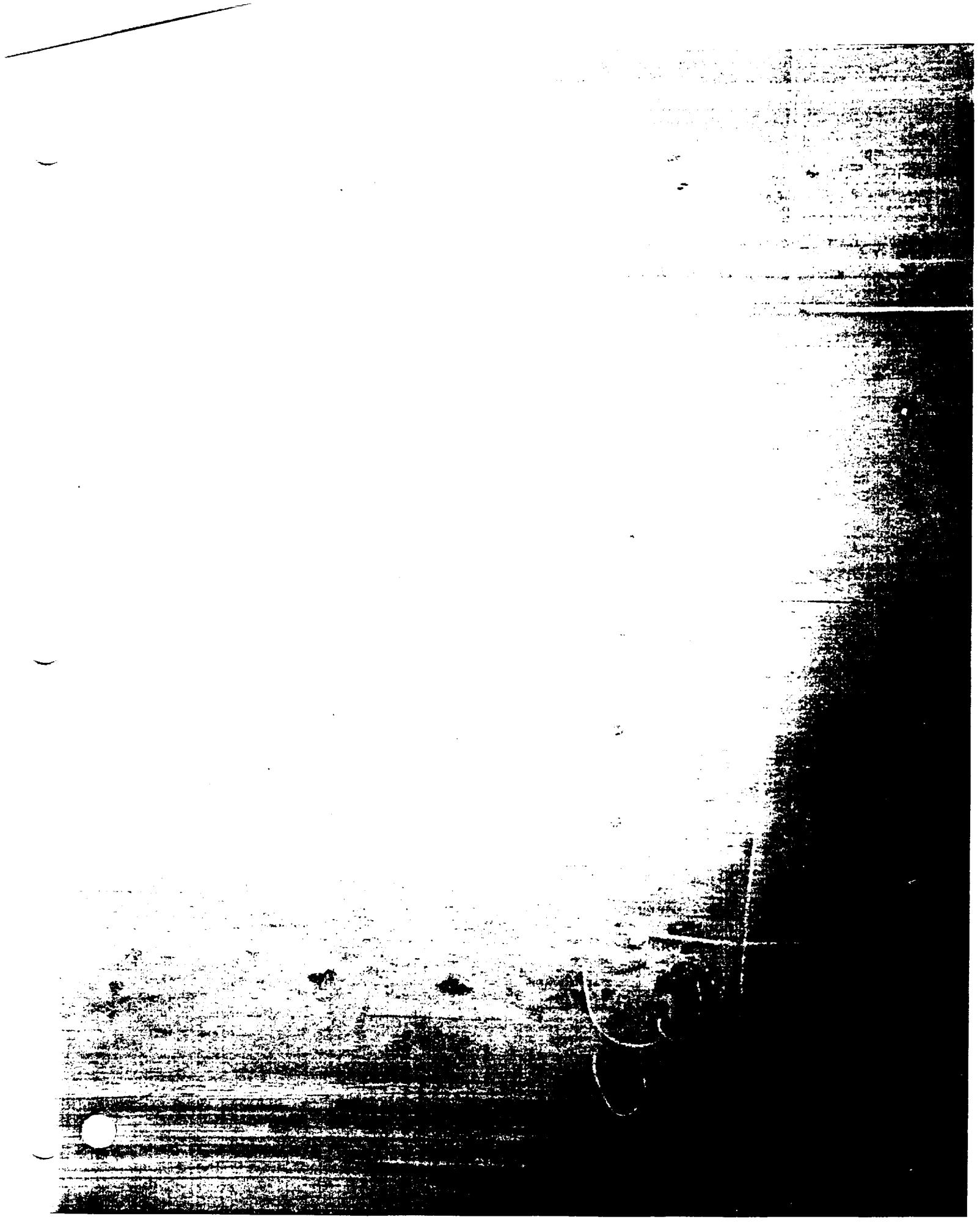


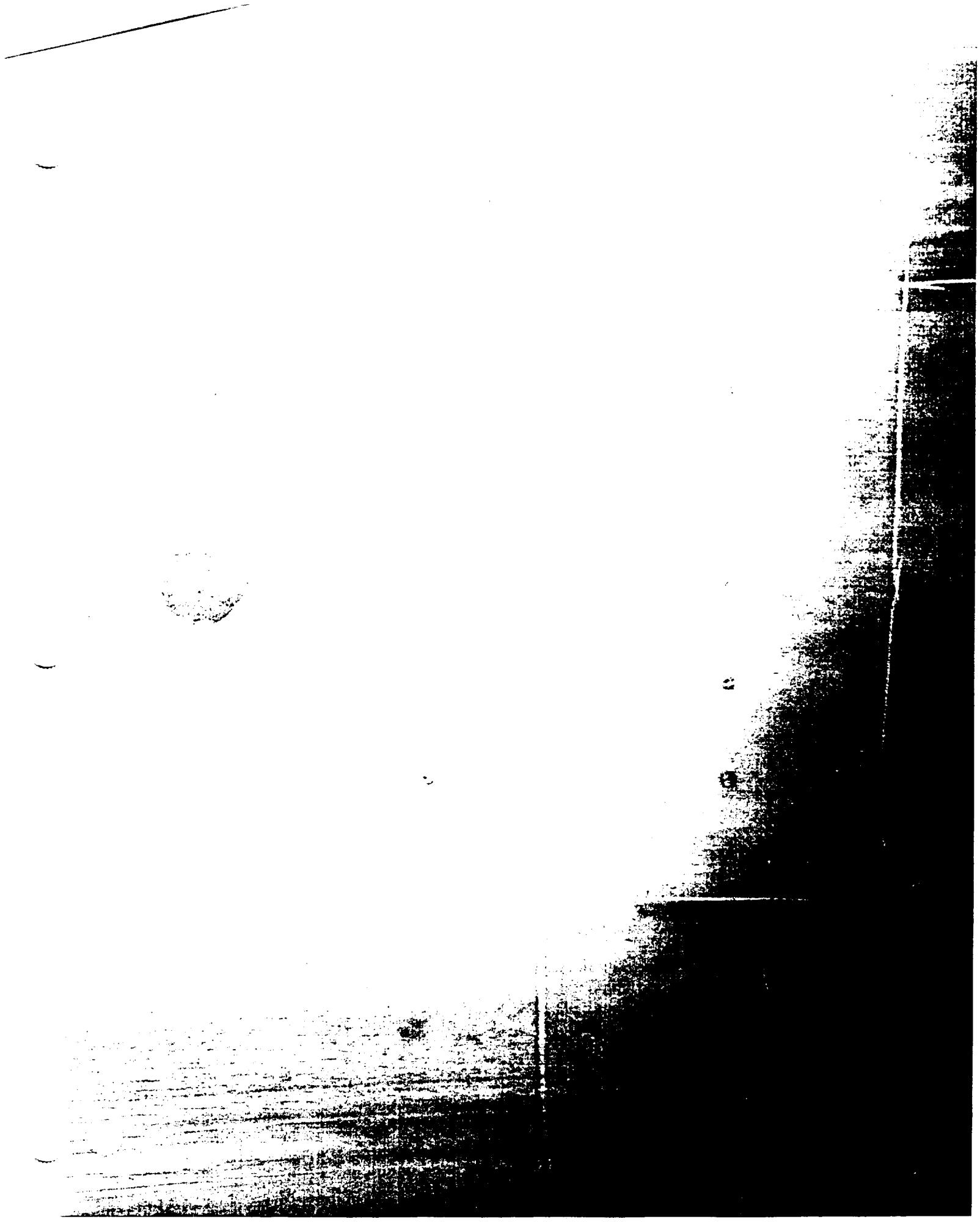












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